"Everything should be made as simple as possible, but not simpler." - *Albert Einstein*

AERIALS (ANTENNAS) 4 - Notes and Queries

Antennas 1 | Antennas 2 | Antennas 3 | Antennas 5 | Antennas 6 | Antennas 7

Index To Other Antenna Pages:
Antennas 1 : Aerials used by M0MTJ
Antennas 2 : Including ideas for compact aerials for Top Band /160 metres
Antennas 3 : Felix Scerri VK4FUQ discusses Loop Antennas, baluns, masts & other antenna related topics
Antennas 4 : Many antenna ideas from various sources particularly for Multi-Band operation & also gives information about...
antenna trimming, knots for wire antennas and useful antenna rigging accessory ideas.
Antennas 5 : Half Wave End Fed antennas for 144 MHz VHF / 430 MHz UHF and 50 MHz 6 Metre band & J-Pole Aerials
Antennas 6 : Simple and effective H.F. Antenna ideas - Ground Plane and All Band Doublet
Antennas 7 : Omni-Directional - Circularly (Mixed) Polarized Antenna for VHF / 2 Meters.

Multi Band Aerial Options | Useful Aerial Rigging Accessories | Aerial Trimming Chart | Useful Knots | A few antenna related Links

As G4ILO notes: An antenna may have two of the attributes: Small; Efficient or Broadband (works over a wide frequency range without retuning) but never all three.

Marconi spins in his grave every time a ham buys an aerial instead of building it ! *(W1GFH)*

THE QUEST FOR MULTI - BAND OPERATION - In A Limited Space

The aerial is arguably the most important part of any station. No matter what transceiver is being used it is the aerial that is the last and most vital link in the chain and needs to be efficient and effective to radiate the signal to best best effect. Some amateurs are quite content to operate on one or two bands while others might want to be able to operate on many or even all of the amateur HF bands. When I gained my licence I definitely fell into the latter camp!

It seems, then, that the holy grail of many amateurs is the perfect multi-band aerial!

Luckily N4UJW has designed a new limited space 160m through to 70cm marvel antenna the plans of which can be found here:
http://www.hamuniverse.com/antwish.html

Having experimented with various types of antenna I am of the opinion that, perhaps along with many other amateurs, for simplicity a resonant dipole is the most efficient and effective of aerial. A resonant dipole it is only a single band aerial of course, but it is extremely cheap and very simple to make - and it's a very efficient radiator. So one could make a dipole for every band of interest and simply swap aerials to work different individual bands. Unfortunately the aerial described by N4UJW does not exist and compromises, such as lack of bandwidth or poor radiation efficiency, have to be made.

The principal of lowering a dipole cut for one band, removing it and hoisting another dipole cut for a different band in to place sounds pretty straightforward, but would the process become frustrating after a while. I think it could, so what about an antenna that will allow operation on several bands?

The Quest For A Multi - Band Aerial

Here is a collection of commercial and 'home brew' (DIY) antenna ideas that will allow multi-band operation, many of which could also be used in a location that offers limited space. Perhaps this only scratches the surface, but hopefully will provide a good starting point and fuel the mind in a quest for a good multi-band HF aerial. Do check out the manufacturer and supplier websites given on this page for lots more options and details.

Home Brew! It has been said that no radio amateur should ever buy an aerial - especially a wire aerial! Joe Tyburczy WB1GFH also comments about suitable antenna installing weather on his web pages:

"When you put up your antenna is also crucial. I must mention here the importance of what many early hams called "antenna weather". That is, snow, sleet, freezing rain, or combination of all the above. It has been proven time and time again that any antenna installed in conditions better than abysmal will not function worth a darn. Or, put another way, it takes bad weather to put up a decent antenna. Dark and cold New England winter days are ideal for this activity. Any antenna erected on such a day will inevitably produce miracles." Joe Tyburczy WB1GFH

G-WHIP
Antenna Products
Top Quality
British Manufacture

Most of what is available commercially could be 'home-brewed' if one has the time and a few suitable mechanical skills.

It's worth bearing in mind that Joe Tyburczy's $4.00 Special may well be more effective than a commercial antenna costing $400.00. Perhaps the equally inexpensive Zepp Antenna could produce far greater Value For Money than shelling out £$hundreds on a commercial antenna?

I give no particular recommendation here, but a good rule of thumb is not to believe the marketing hype of any commercial company supplying antennas.

A good place to start is, I think, the classic All Band Doublet Antenna, which is mentioned several times below. Plenty of links are also provide further down this page.

As important as not believing any of the marketing hype is remembering the words of the Star Ship Enterprise's Chief Engineer Mongomery Scott; (paraphrasing) *You cannae change the laws of physics!* - Size matters. A coil loaded 5 foot long aerial probably won't be that much good on the H.F. bands. Indeed, a a 5 meter long antenna may be perfect for the 10 metre band but it won't be a great antenna on 20m, and certainly even less effective on 40m and 80m

So, before falling for all the marketing hyperbole its wise to read up on a little antenna theory and do some lengthy research into the antennas being considered before making an expensive decision.

Below are a few clues and ideas listed in no particular order - some of the antennas will be great while some of the commercial designs shown below may promise great things but fail to meet high expectations.

There is no "miracle antenna". If one understands the theory and the compromises made with shortened, under-sized, multi-band (and often very expensive) antennas there may not be so much disappointment. However most will be compromised in one way or another, so if one is happy to live with those compromises, understand what they mean, and are happy to have a lighter bank balance then that's fine!

Low SWR across all the bands does not indicate a good antenna. My dummy load has very low SWR across all the bands but it is most certainly not a good antenna!

Someone telling you that the antenna that they're using is great and that they've worked the world doesn't mean it really is a good antenna - it's just 'hearsay'. One could quite possibly work around the globe on a coat hanger in the right conditions - it doesn't suddenly make a coat hanger the great antenna that should be widely heralded!

The best way to learn about antennas is to go out and make some - well actually go out and make many antennas.

Here are a few ideas. Some that are easily 'home brewed' and some commercial ideas that could be adapted to 'home brewing'. I don't have any particular recommendation, but I hope that this list will provide some good food for thought. (Some of the commercial antennas may be okay, some may be awful).

Remember; ***Marconi spins in his grave every time a radio amateur buys an aerial instead of building it !***

The Doublet Antenna - the classic all band / multi-band Aerial

The Doublet Antenna is my favourite Multi-Band aerial. The main benefits of a Doublet Antenna are that it can be

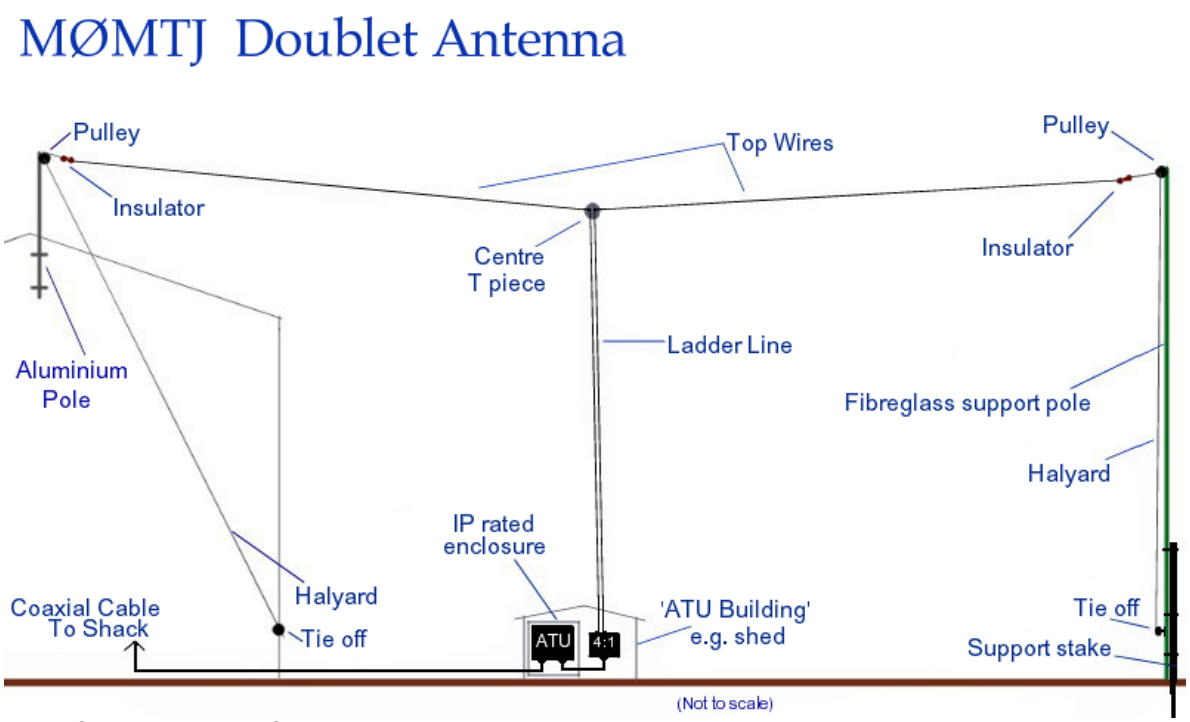
used on whatever frequency it is cut for, and higher frequencies. Usefully, there can be some useful gain on higher frequencies, although there will be some petal shaped lobes on the higher frequency bands.

In fact my 20 meter long Doublet for the 40meter band to the 6 metre band also works quite well on 80 meters! Not only a very good starter antenna for those looking to work as many bands as possible, but also an aerial that would be useful and efficient for years and years to come.

Ladder line or open wire feeder must be used (NOT coaxial cable). Ladder Line or open wire ensures low loss at High Frequencies so that as much of your precious transmitter power as possible will be radiated. Likewise receive efficiency should be maximized. Assuming that the aerial is successfully balanced, the feeder should not radiate, even when there is (inevitably) high SWR

High SWR is not an especially bad thing and will not reduce the aerial's performance, but note that high SWR on the balanced feeder does increase feeder loss compared to a when matched - but the losses will be a lot less significant then if coaxial cable were to be used. This ensures that efficiency should be better so that all the power that reaches the antenna wires will be radiated - save for any losses in the antenna tuning unit (AMU) or the balanced feeder cable.

Remember: Ladder Line = Lower Loss - Read more about my M0MTJ Doublet Antenna HERE >> and more notes on this page here >>



The Classic All Band DOUBLET ANTENNA - Read More about my M0MTJ All Band Doublet Aerial Here >>>

The G5RV and more about Doublets & Dipoles

The G5RV - (Even Louis Varney himself said that a Doublet would be better!)

Why the G5RV continues to remain popular is a mystery. The 'legendary' name, perhaps? That it can be 'thrown up' without too much thought? The fact that it' cheap and cheerful? Well, cheap anyway. There has been much written about the G5RV and the overall conclusion is that it's not a very good multi-band antenna. Certainly it will work quite well on, perhaps, a couple of bands, but there are better alternatives, especially when one considers the wide availability of remote automatic antenna matching units (remote auto 'a.t.u.'s) that will greatly assist in minimizing antenna feeder losses.

Perhaps the best thing that can be done with a G5RV is cut off the coax, re-size the top wires and turn it into a true Doublet Antenna - or, better than that, don't buy a G5RV in the first place and simply make (home brew) a true All Band HF Balanced Doublet Antenna.

The G5RV and its derivatives such as the Western HF-10 and the ZS6BKW are a bodge. In fact, Louis Varney G5VA himseld stated that a much better alternative to any of these 'G5RV' designs is to run the open-wire line from the center of a dipole all the way to a balanced antenna tuner!! This aerial arrangement will work on ANY band from 80 metres through to 10 meters.

The G5RV is, therefore, not the most efficient aerial and, as users report, may not always be the easiest to use, but because it is coax fed, it remains an ever popular choice because it's easy to feed the coax cable from the antenna's location back to the shack. Unfortunately this easy (lazy?) approach means lots of loss due to high SWR on the coaxial cable.

One may say, Oh well, there's perhaps only 2 or 3 S points in it. (Cough!). A difference of 3 S points is the difference between radiating 100 watts or only radiating 1.6 watts. Um, - I'm sure we'd soon complain if our shiny, new 100 watt transceiver only produced 1.6 watts!!

QRP and lower power portable operators should be especially keen to minimize antenna system losses so that as much power as possible is radiated. Losing 3 S points from a 5 watt FT-817 results in only 0.08 watts. QRP operators may likely favour resonant, single band antennas for greatest efficiency.

Coaxial Cable is only 'low loss' when the antenna impedance is similar to the cable's designed impedance of 50 Ohms, or near 1:1 SWR (or at least less than 2:1). Coax cable is therefore fine for a Dipole antenna that is designed to be resonant on one band of choice, which will have a reasonably low SWR across that band, but coax' is entirely unsuitable when one wants to use the aerial on several bands. The G5RV will be used an multiple bands and will therefore present widely varying impedance values (and SWR) depending on the band of operation and so the power losses will be significant.

Note: The antenna's true impedance (SWR) must be measured at the antenna's feed point (i.e outside and up in the air) not at the radio end of the cable, in the shack, where the coaxial cable's losses will mask the true SWR reading. Unfortunately 50 Ohms, or a near 1:1 match, will not be encountered on any band on a G5RV. The best band will be 20 metres at typically 2:1 (100 Ohms), but on any other band the impedance will be very much higher. One might expect rersults like these: 80 metres 3:1 to 5:1, 40 meters 5:1, 30 metres 20:1 or more, 17 metres 15:1 or more, 15 metres 6:1 to 12:1, 12 meters 3:1, 10 meters 10:1 to 20:1.

1000 Ohms into 50 Ohm coaxial cable will result in a massive dumping of your power - lost as heat in the coaxial cable instead of being radiated as a useful signal. However, high SWR is not in itself a bad thing - it's just that the correct type of feeder and impedance transformation method needs to be used. The *incorrect* feeder is coaxial cable - the correct type of feeder is balanced Line or Ladder Line feeder. This can be the typical slotted 300 Ohm type or the 450 Ohm 'window line' which are commercially available. Even better, make your own open wire, balanced line feeder. Spacers can be bought commercially or 'home brewed'. The spacing for this parallel line should be about 2 to 3 inches (50 to 80 mm) - the width of the spacing is not particularly critical, but whatever width is chosen should be maintained as accurately as possible along the length of the feeder - i.e. it should be parallel.

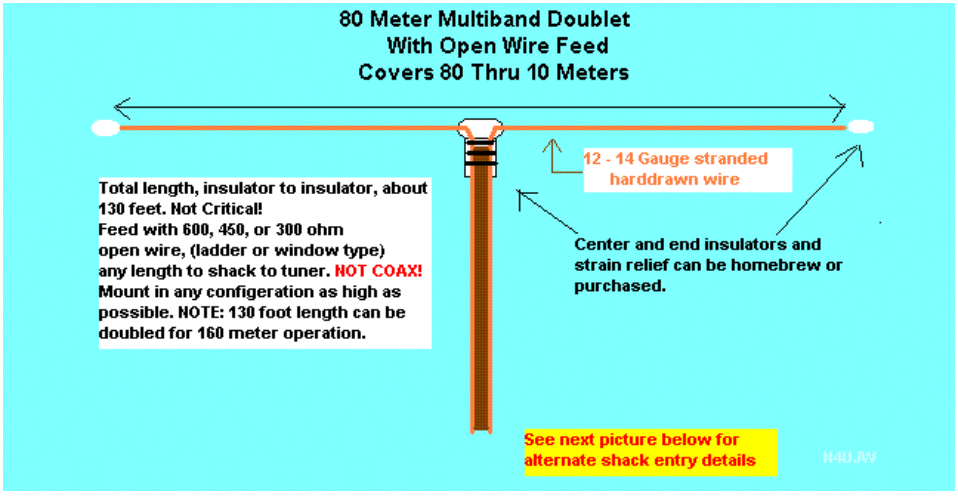
The Doublet can take more time and effort to tune, prune and adjust. It will also need a good antenna matching unit (so-called "ATU") and low loss balun, but the reward will be more effective performance due to the much reduced loss in the balanced line feeder system.

Doublet Aerials - a better alternative to a G5RV

Check out the The classic All Band Doublet and the NorCal Doublet for very simple, effective and versatile antennas for multi band operation:

The ALL BAND Doublet Antenna

This could very well be the first antenna that one should try in order to get on at least one band very efficiently but also several other bands with the use of a good ATU.



All Band Doublet - http://www.hamuniverse.com
See My All Band Doublet Antenna here

The all band Doublet antenna is nothing more than a 1/2 wave dipole cut for your lowest operating frequency and fed with twin lead, ladder line, open wire, etc to a tuner that will accept a balanced line connection. IT MUST NOT BE FED WITH COAXIAL CABLE !

It can be designed for use from 160 through to 10 meters very easily using the standard 1/2 wave dipole formula:

468/freq MHz = total length (ft)
The exact length is not critical!

If there is insufficient room for a lower frequency version (160m or 80m), then the Doublet can be designed to the shorter wavelength of the 40 metre band and used up to the 10 metre band. (Do not attempt to operate on a lower frequency than 7 MHz in that case since this could damage the a.t.u.) It may be possible to connect the ends together and tune it against earth - if you have a good enough earth - and use lower frequency bands. For best results a doublet should be mounted as high as possible (as with many aerials) and can be erected as a flat top or inverted V.

A Doublet Antenna needs a good antenna matching unit with a wide impedance matching range (obviously not the one in the radio!). Preferably this should be a balanced antenna matching unit, but an unbalanced matching unit can also be used together with a good low loss current / Guanella balun, such as the extremely high quality items available from G-Whip Antennas. I use a 4:1 G-Whip guanella current balun with my Doublet, but many users recommend using a 1:1 ratio current balun - again, this is a case for individual experimentation.

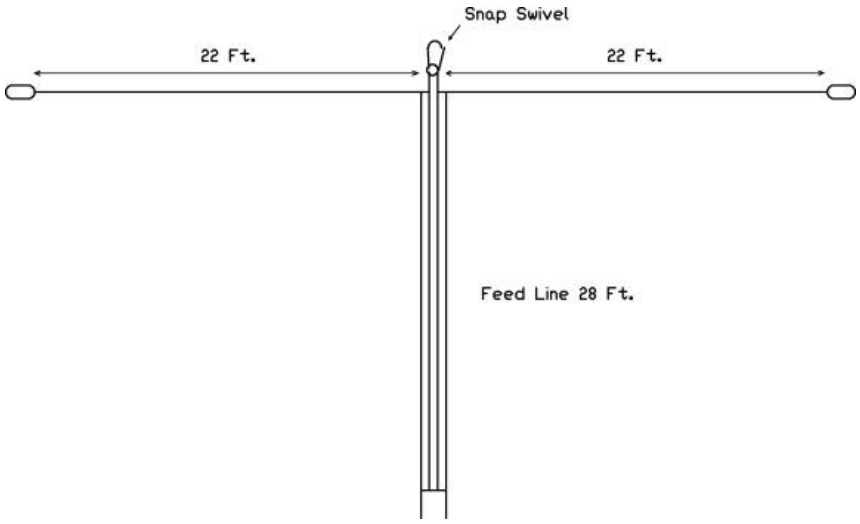
A more detailed description of the Doublet Antenna can be found here >>

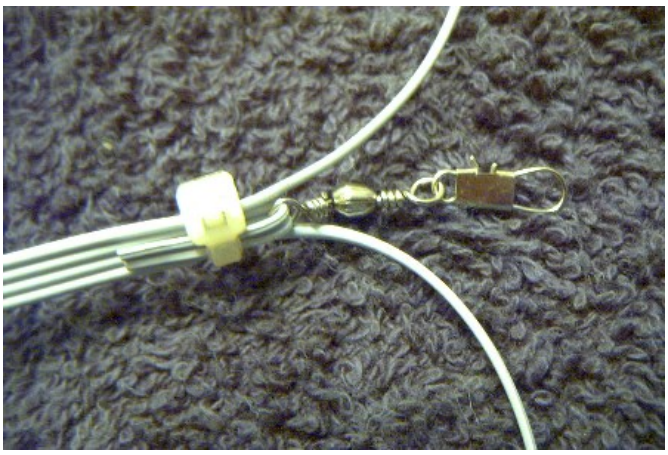
External Links

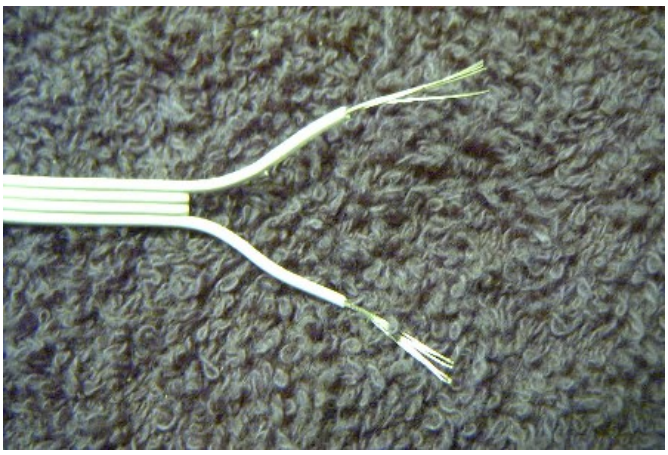
The All Band HF Doublet can also be found on Ham Universe: http://www.hamuniverse.com/hfdoublet.html

Introducing The All Band Doublet by the late L.B. Cebik W4RNL: http://www.cebik.com/content/edu/edu6.html
N.B. Create a free account at http://www.cebik.com

The Norcal Doublet







The Norcal Doublet Antenna: http://www.norcalqrp.org/norcaldoublet.htm

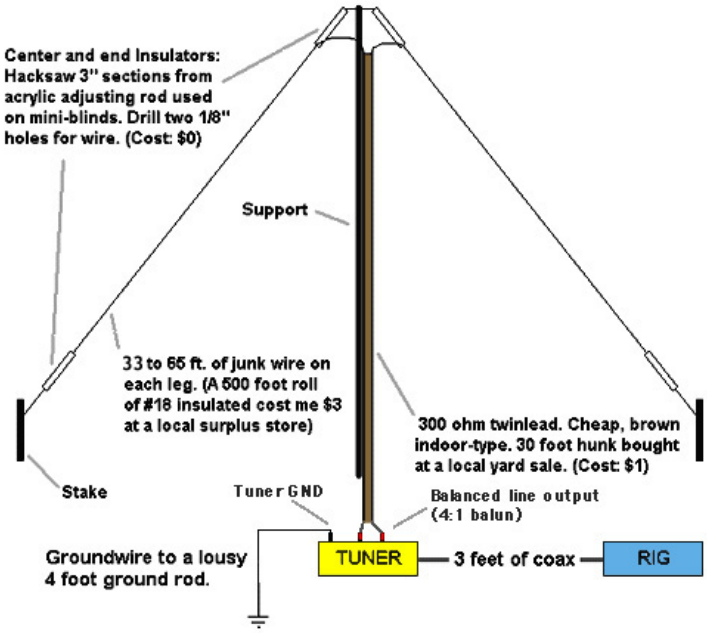
The Norcal Doublet is a simple antenna that is 44 feet (13.4 metres) long, 22 feet (6.7 metres) per side. The Norcal pages report "...that the antenna would have basically the same radiation patterns on all bands from 40 - 10 meters. This would be very handy to have for field operation..... You will need the following materials: 50 feet of 4 core stranded computer cable; 1 #0 Fishing Swivel; 1 Cable tie; 2 pieces of fishing cord."

The antenna can be hung from trees or cheap telescopic 'roach' / Sota poles. Doubling the size would allow operation on 80 metres and even 160 metres by shorting the twin feed together at the transmitter end and feeding it against a good earth as a 'Marconi' type antenna.

An effective multi-band "4 Dollar Special" by Joe Tyburcy - W1GFH (An Inverted Vee Doublet Antenna - super cheap - super effective - multi-band)

Joe Tyburczy, W1GFH provides some sensible insight and advice, he writes: *"I am a big fan of "balanced line" (twin lead, open wire line, etc.) vs. coax. By using balanced line and a tuner you can have one, single-element antenna that works well on all bands. You can't do that as easily with coax. The basic "W1GFH $4 SPECIAL" shown below is a variation on the type of versatile skyhook I've been using for years.....Now at this point, some of you may be looking at the diagram and muttering, "Jeez Joe, that's just a dipole fed with twin lead and used with a tuner". Well of course it is. Virtually all antennas are "di-poles" (i.e. "two sides") in some form or another. This one just happens to be made from low-cost materials.....I won't go into the theory here, but trust me: balanced feed line, properly used, does not "leak" RF and is less lossy than coax. I've tried the commercial 450-ohm ladder line, but prefer 300-ohm TV twin lead, and the cheaper the better. Radio Shack TV twin lead is ideal. Home Depot has some good stuff, too. Forget all the obsessive junk about standing waves, impedance and velocity factor. What you really need to concentrate on is getting an interesting set of antenna insulators."*

Read Joe's excellent article in its entirety here: http://www.qsl.net/wb1gfh/antenna.html



4 Dollar Special by W1GFH
http://www.qsl.net/wb1gfh/antenna.html

Inverted L - 80 metres to 10 metres

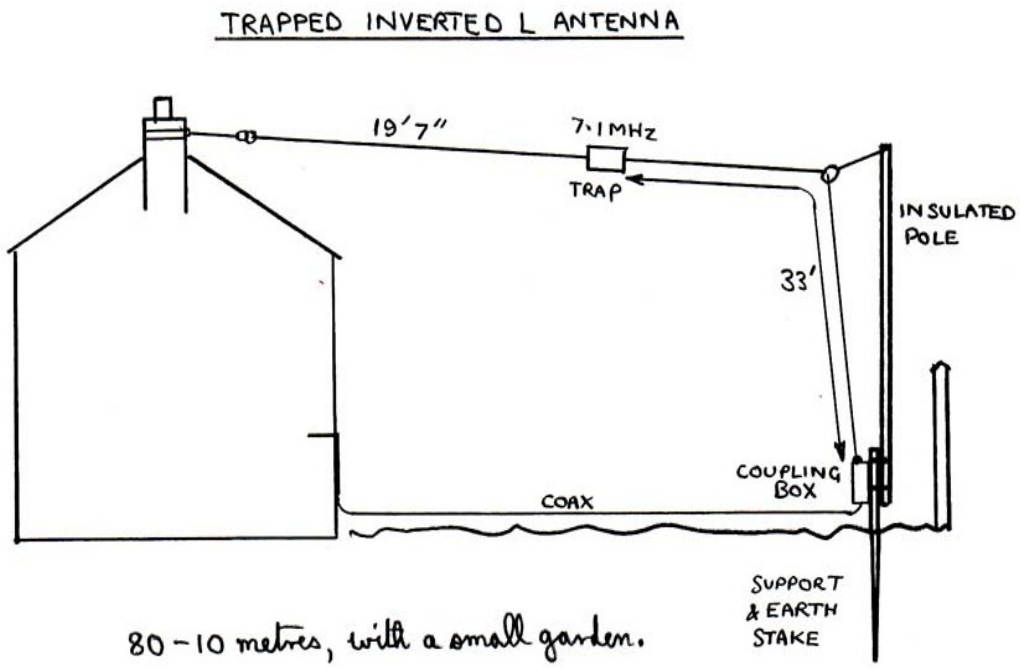
A typical Inverted L antenna will be trapped for 40m/80m using a 7.1 MHz trap. It is essentially one half of a W3DZZ dipole so can be accommodated very much more easily into a small plot or garden - especially as part of the antenna is running vertically up a wooden or fibreglass (non conductive) pole. This should allow it to be fitted into quite a small garden such as mine. It's a very useful antenna in this respect, and because there is a good length of wire in the air, it radiates quite well.

The Inverted L is also a very effective aerial because it has the benefit of both vertical and horizontal radiation. While Inverted L's might make good TX aerials, like ground mounted vertical aerials they do have the potential to be a little noisy on RX. This will depend upon local circumstances and noise sources. However the fact that the feed point will generally at the bottom of the garden, well away from the house may help to keep QRM to a minimum.

The Inverted L is extremely easy to 'home brew'. Spectrum Communications can also supply the complete aerial as shown below. It should give excellent performance on 80m and 40 metres, with 20 metres also being good but also allowing use on 15m and 10m and possibly one or two of the WARC bands.

If you fancy home-brewing the complete antenna, except for the 7 MHz trap, traps are available to buy commercially from suppliers such as Spectrum Communications and Sotabeams who supply very neat and lightweight devices,

Use a Remote Automatic Antenna Coupler : The use of a good Automatic Antenna Coupler, such as the CG Antennas CG-3000, at the feed-point with a simple inverted L wire will provide a very good Multi-Band aerial that could be used on all bands between 160m and 10m and should be very simple to deploy.

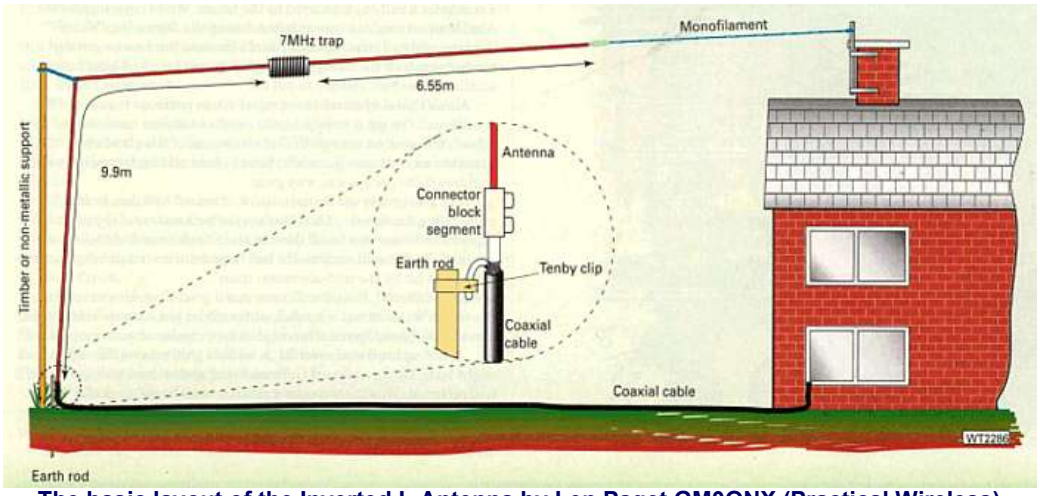


Spectrum Communications Inverted L - benefits from both vertical and horizontal radiation
http://www.spectrumcomms.co.uk

More about Inverted L Aerials:

The Inverted L for 40m/80m is shown below is essentially one half of a W3DZZ dipole fed against ground using one 7.1 MHz trap. It's a very compact antenna and is simple to construct. It is most efficient, of course, on 80 metres and 40 metres, but can also be used, with an a.t.u., on 20m, 15m and 10m.

Find out how to make one here: http://www.users.icscotland.net/~len.paget/5%20band%20Inverted%20L.pdf

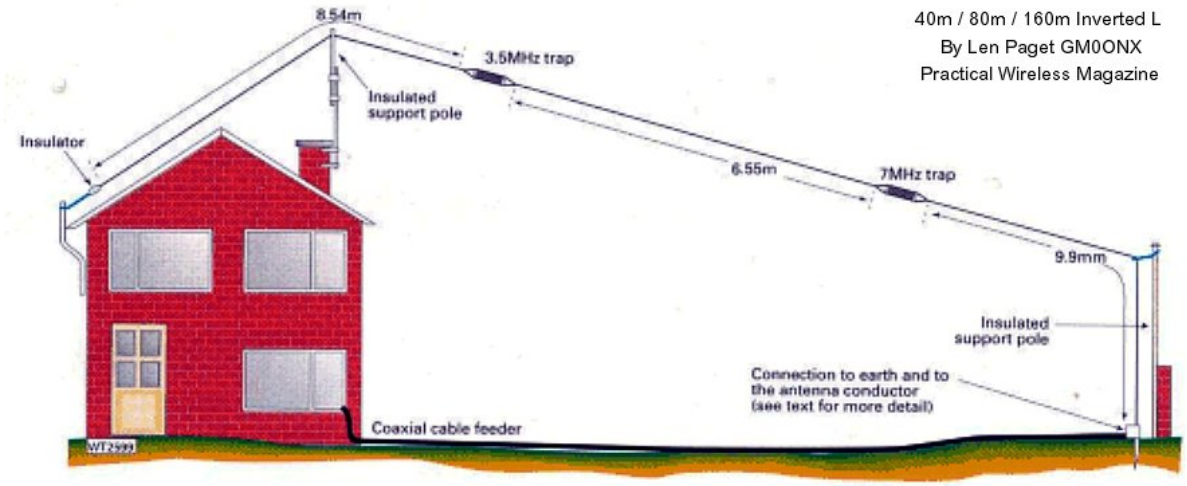


The basic layout of the Inverted L Antenna by Len Paget GM0ONX (Practical Wireless)

Adding 160m / Top Band to an Inverted L

The 160 metre Top Band can be added to this aerial by connecting a 3.5 MHz trap at the end of the 80 metre wire (where to monofilament joins the 6.55m section of wire below) with another length of wire on the other side, increasing the overall length of the antenna.

Find out how to do it here: http://www.users.icscotland.net/~len.paget/Inverted%20L%20adding%20top%20band.pdf

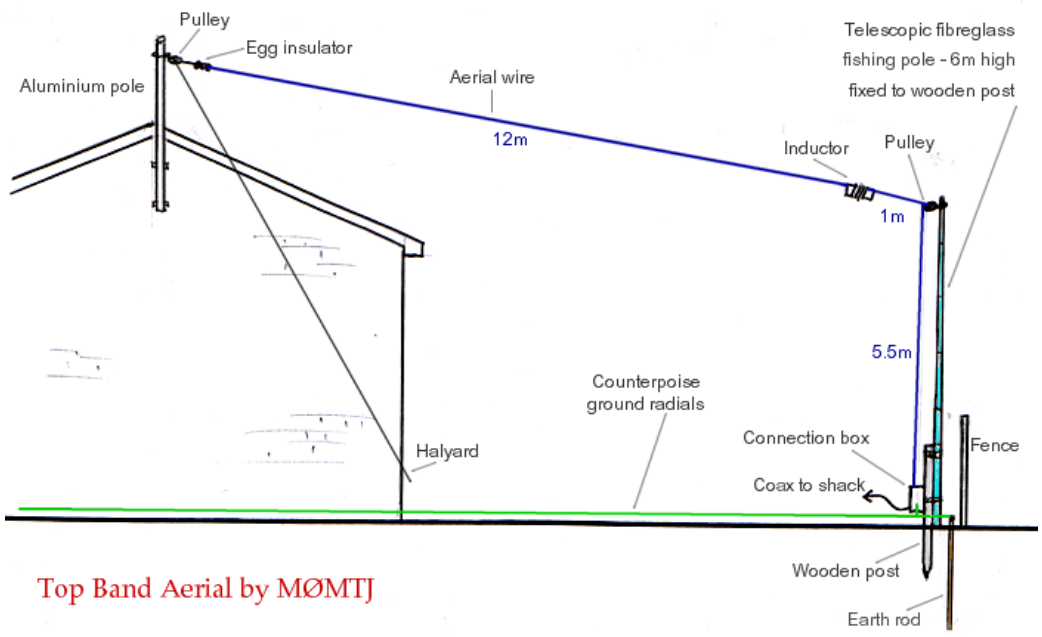


Adding Top Band to an Inverted L by Len Paget GM0ONX (Practical Wireless magazine)

160m Top Band 'Inverted L' Wire Antenna

At the time of writing I am using a 40m/80m Inverted L aerial and in an attempt to get on Top Band I have also been experimenting with a shortened 160m antenna in an inverted L configuration that uses a wire about 19 metres long - about half the size of a full size inverted L for 160 Metres.

A Top Band aerial of this type also needs a very good ground / counterpoise and can suffer the disadvantage, like ground mounted vertical aerials, of being rather noisy on RX . The drawing below shows the general idea. Read more here >



General layout of Top Band Aerial with fibreglass pole retracted to a height of 2 metres
Wire lengths are approximate: Inductor 5cm dia with approx 40 turns of enamelled copper wire

Full Wave Loops and Delta Loops - An easy to install and effective antenna for multi band operation

Easy and low visual impact - a full wave loop: With a larger garden a full wave loop could be easily accommodated horizontally without the neighbours even noticing. A garden with a perimeter of 40 metres would

easily accommodate a full wave loop for the 40 metre band and would work up to 10 metres or even 6 metres with an 'ATU'. A garden with a perimeter of 80 meters would accommodate a full wave loop for the 80 metre band and would work up to 10 metres.

Small Loop for 20 metres to 10 metres: A loop for 20 metres or 17 meters is relatively compact and could easily be installed in small 'postage stamp' sized gardens. A loop antenna could be triangular, square (Quad) or circular, but a square loop (and indeed a circular loop) would need more supporting points than a delta (triangular) loop, so a Delta loop is likely to be the easier option.

The loop is really a single band antenna cut for one wavelength on the band of interest, however it can also work quite well as a cheap and easy to install multi-band H.F. aerial. A loop consisting of a 17 metre length of thin antenna wire, for example, will work well on 17 metres but may also give 15m, 12m and 10m with an ATU. My own loop is made from an 16 metre length of wire, tuned for the 17m band, but can work on higher bands. A 40 metre loop will be considerably larger, but it might still possible to accommodate in many fairly compact gardens. Performance will depend on height and orientation.

Feeding the loop at the top or bottom will give horizontal polarisation, while placing the feed point on the side will give vertical polarisation. The apex can be at the top or the bottom, but performance should be better with the apex at the bottom with the flat wire across the top - however for ease it may be more convenient to support a Delta Loop on a single pole, meaning that the apex would be at the top.

Ideally a loop should be fed with balanced line back to the shack, connected to a balanced line ATU or other ATU via a 4:1 balun. Alternatively use a 4:1 balun at the antenna end and run 50 ohm coax back to the ATU / txvr - though losses will be greater doing it by this method if the coaxial cable is quite long.

If one can install a separate antenna for the lower frequency bands of say 160m, 80m and 40m, then a Loop Antenna could be a good partner to allow operation on the higher bands of 20 metres to 10 meters or even 6 metres.

A loop should be really very easy to install using a single support pole and very cheap too! All that's needed is the supporting pole, some cheap wire, a 4:1 balun which can be 'home brewed' and some thin cord and insulators which should not be an eyesore either.

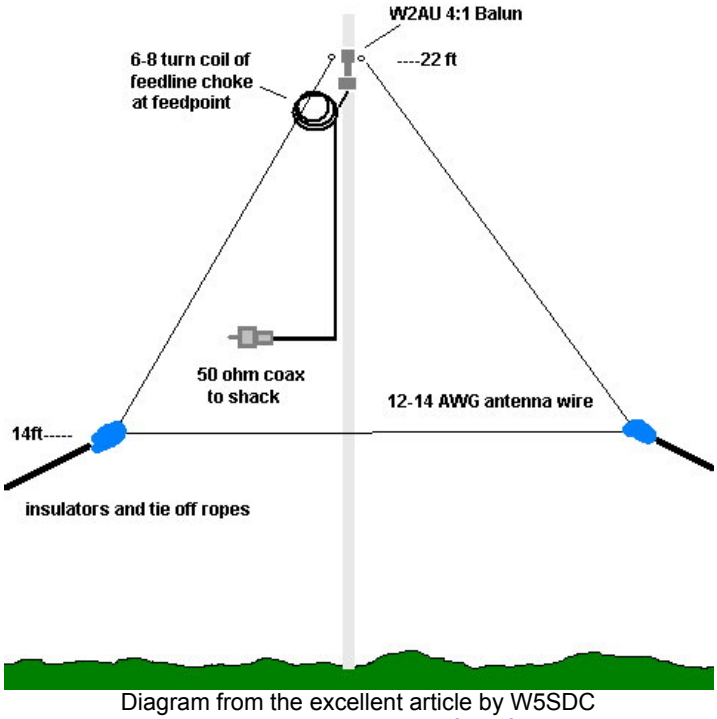
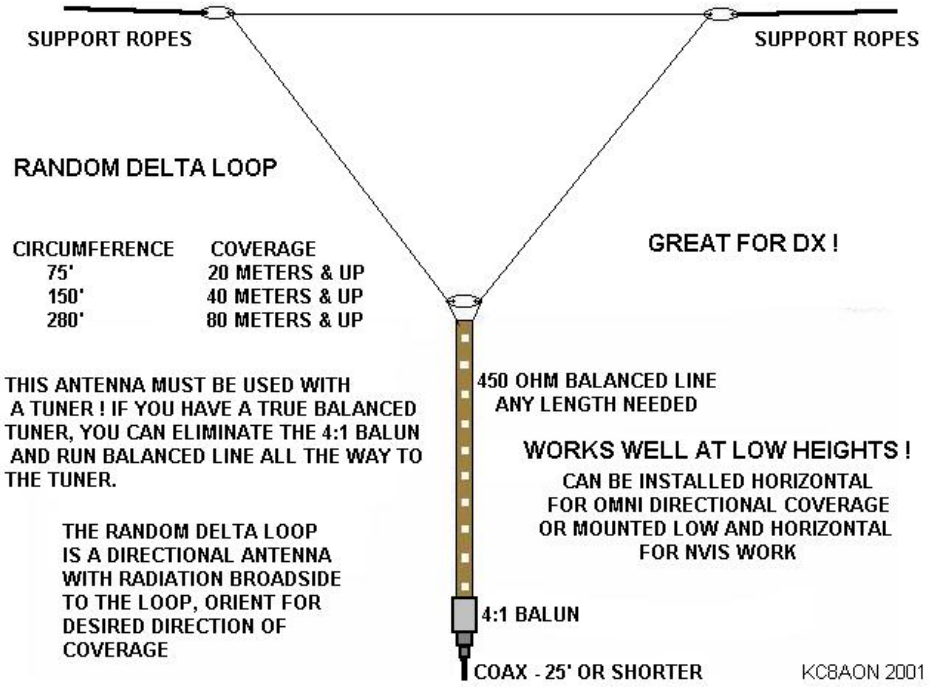


Diagram from the excellent article by W5SDC
http://w5sdc.net/delta_loop_for_hf.htm

Band	Length of antenna wire at mid band in metres
10	10.617
12	12.282
15	14.432
17	16.90

20	21.502
30	29.622
40	42.842
80	82.234
160	161.223

Delta or Quad Loop Antenna - An ideal multi band antenna solution?



A Multi Band Wire DX Loop Antenna by KC8AON
http://www.i1wqrlinkradio.com/antype/ch10/chiave1827.htm

Delta Loop by Arthur M0PLK (SQ2PLK)
Details at http://pdxa.one.pl/articles.php?article_id=17
Available at http://ham-radio.urbasket.eu and http://www.vpa-systems.pl/

Using fibreglass fishing poles (Sota Poles) two 7 metre long poles can be erected in an inverted V shape and used to support a 20 metre delta loop which will be usable on 20m to 10m and also adaptable for use on the 40 metre band.

The two aerial wires used are connected directly to a 4:1 balun which is, in turn, connected to an ATU such as the Z-11 Pro or Z-100 via coaxial cable. See this page which shows the W6ZO delta loop to get for the general idea of what will be achieved. The finished aerial will be very much like the commercially available ProAntennas DMV-Pro.

W6ZO Delta Loop - fed with 4:1 Balun - 40m to 10m
http://www.fros.com/KI0GU/w6zodelta.htm

The Loop Antenna. Ideal - cheap, easy, multi-band, simples! -
Lots of links to other Loop Antenna information on the links page here

Omni Directional Multi-Band Horizontally Polarized Delta Loop

If all that can be erected is a single pole, masts or telescopic pole, here is an option that will provide a horizontally polarized signal on 20 / 17 / 15 / 12 / 10 metres - the Sandpiper Aerial Technology GM3 (designed by GM3VLB). A similar idea, providing omni-directional horizontally polarized signals, is the G3TPW Cobwebb Antenna from Steve Webb.

These look like good ideas, though I have yet to make one to test.

G-WHIP
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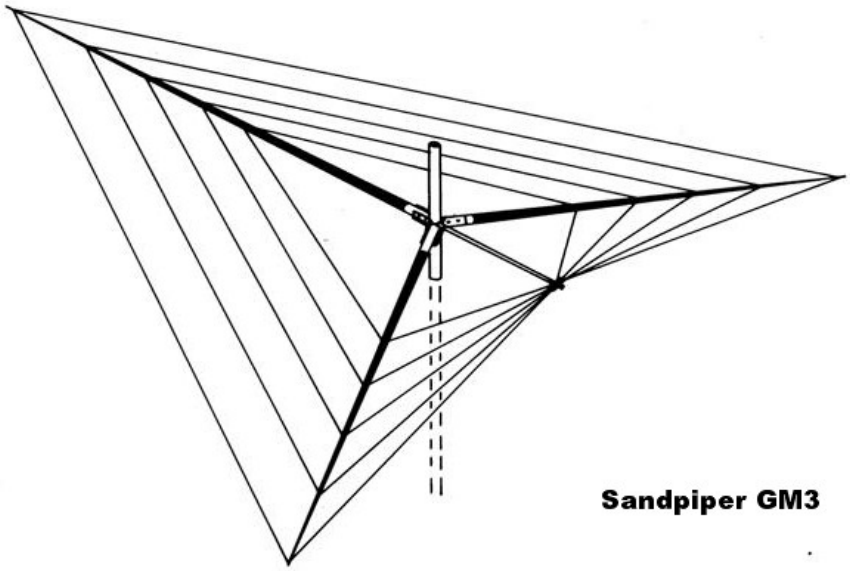


Sandpiper GM3VLB Antenna
http://www.sandpiperaerials.co.uk/

G3TPW Cobwebb Antenna from Steve Webb - photo by G3TXQ
http://www.g3tpw.co.uk http://www.karinya.net/g3txq

Resonant Vertical Antennas

Low SWR: Having a low v.s.w.r. across the whole of HF may seem, at first glance, to be a good thing - but my dummy load has a very low v.s.w.r. from HF to UHF, it does not make it a good antenna! As far as aerial systems are concerned, having a low v.s.w.r. across the whole of HF is probably not the best way to judge an antenna - a wide band low v.s.w.r. could indicate a fault with the aerial or feeder system - or just that lossy matching transformer that is gently heated up by the power applied from the transmitter!

A low v.s.w.r. is a good thing in a resonant antenna. It will help demonstrate the antenna's point of resonance - but the v.s.w.r. will rise either side of resonance. So:

The next commercial option is an antenna that is truly resonant on a number, but perhaps not all, bands. The Hustler and Butternut varieties are very well known and offer well reported good performance.

Some vertical antennas use traps to achieve multi-band performance and as such are essentially one half of a trap dipole, fed against ground. A consideration is that the traps themselves, particularly if multiple traps are used, will introduce losses to the antenna system. It should also be noted as an additional consequence of using traps on a ground mounted vertical antenna, is that the highest frequency element will inevitably be positioned at the lowest position on the aerial - not a good position to be, especially for local ground wave radiation where signals will more easily be screened by local structures. Ground conductivity also needs to be good for verticals to operate efficiently.

The Hustler 4-BTV, 5-BTV & 6-BTV aerials are examples of multi-band verticals that use traps; many amateurs report great success with Hustler aerials - and it is very low profile too, indeed an amateur friend of mine uses a Hustler with great success and has even modified an additional top resonator so that the aerial can be used on 160 metres..

Other manufacturers of resonant vertical antennas, using varying design methods, include GAP, Cushcraft, Diamond, HyGain, and the well known British names Moonraker and Sandpiper.

Advisory: These are perhaps a good idea for limited space situations, but the shorter versions will not work well on the lower HF bands. A 6 metre tall antenna cannot possibly work terribly well on 40m or 80m, but may work well on the 20 metre band and above. However one could easily 'home brew' an equally effective antenna for a fraction of the cost of a commercial antenna.

Sandpiper Aerials

Sandpiper Aerial Technology offer an enormous range of amateur radio antennas from HF to UHF. For HF working Sandpiper offer numerous options including simple multi band resonant antennas supported on fibreglass telescopic poles using either changeable or plug-in coils for different bands to the famous V range and shorter and more compact MV range and the Portable MV antenna on its own tripod base. The V and MV ranges use a rather innovative design, seen above right. The V and MV antennas are available in versions that cover all the HF bands - or as cheaper versions that just cover the particular bands of interest. http://www.sandpiperaerials.co.uk/

Vertical antennas will be quite short when compared to the wavelengths of some of the longer wavelength bands (particularly 40m, 80m and 160m) and so will not radiate as efficiently as a full size resonant aerial. The bandwidth will also be quite narrow. Setting up a multi band antenna to be resonant at the required portion of each band can sometimes be a little time consuming, but for the convenience it might be a price worth paying. A vertical antenna will generally have a low angle of radiation which is a good thing for long distance DX but verticals can be very noisy on RX compared to a balanced dipole and as previously alluded to, radiation efficiency will be very low when compared to a full size single band resonant antenna. Attractive options?

Alternatives: My favourite way of experimenting with aerials is using a 10 metre long fibreglass telescopic fishing pole as the support. These fibreglass poles are lightweight and easy to carry, put up and take down, ideal for supporting lightweight v.h.f. and u.h.f. yagis, wire dipoles and doublets and also for supporting vertical wire aerials.

The telescopic pole must be made from fibreglass, not carbon fibre which is electrically conductive.

One great design is by Dave G4AON who writes on his web page: "There seems to be a myth among many newly licensed radio amateurs that an antenna works better if it costs a lot of money..... The antenna shown here costs around one tenth the price of a commercial vertical, yet it will perform as well as (and in many cases better than) a trapped vertical antenna. This antenna is based on a 10 Metre long fibreglass fishing pole.....the poles will collapse inside the sections unless each joint is secured with PVC tape, for more permanent installations glue could be used.

...The wire lengths are calculated from the formula L = 234/F, where F is the frequency in MHz and L is the wire length in feet. These lengths work out to around 33' 3", 23' 2" and 16' 7" for the 7, 10 and 14 MHz bands. The lengths for 7 and 10 MHz were more or less correct, however probably due to interaction between the wires the 14 MHz wire needed lengthening by around 4" for minimum SWR. Wire size is not critical, but it is probably better to avoid the thinnest "hookup" wire. Note, ground conductivity/loss and elevated/buried radials make a significant impact on both the performance and tuning of a ground mounted vertical. In the case of buried radials the vertical may resonate significantly lower in frequency than expected."

The antenna shown on the right is made for triple band operation on 7 MHz, 10 MHz and 14 MHz by the use of parallel wires, but an aerial based on a fibreglass pole could be single, dual, triple or even - at a push - quadruple band.

The more bands included the more difficult it will be able to trim to tune for resonance (as with a fan dipole) so to keep interaction to a minimum the wires should be quite well spaced. Like all quarter wave verticals aerials a good ground plane will be needed.

See G4AON's excellent full article here: http://www.qsl.net/g4aon/vertical/

Horizontal Resonant Wire Aerials

The great advantage of a vertical antenna is that they have a very small footprint, i.e. they can be installed in the corner of many small plots and gardens. True resonant verticals can properly cover many, if not all, the HF bands. However to be reasonably effective a vertical needs a very good ground and also must be quite tall, in the order of 6 to 9 meters in many cases (about 19 to 30 feet). This may cause objections from the XYL. Another disadvantage might be that a vertical has little near vertical incidence skywave radiation (NVIS), a consideration for the lower HF bands, so after the local ground wave coverage there will be little or no signal until after about 500 miles, not good for inter G working. (ref. G8JNJ) - So try some Dipole Antennas:

Dipole Antennas

The dipole antenna is possibly the simplest and cheapest antenna to make. It it cut for single band operation where it should make a very efficient radiator. The simple wire dipole should be quite discrete, though not entirely invisible, but should not raise too many objections from the XYL or neighbours.

For some dipole ideas see this page:
http://www.qsl.net/ta1dx/amator/practical_dipole_antenna.htm

How to make a basic dipole by Marshall N1FN : http://www.morsex.com/dipole/index.htm

Also see this detailed and useful page: http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7499

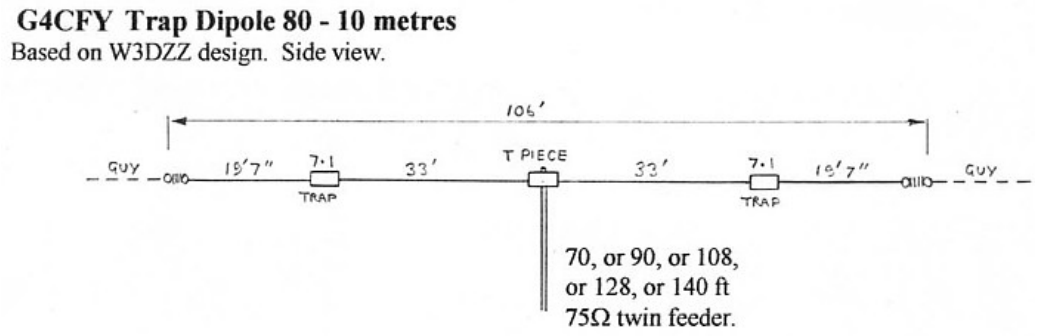
Calculator:
http://www.sean1226.pwp.blueyonder.co.uk/design_your_own_antennas%201.htm

TRAP Dipoles:

The next type of antenna to consider might, then, be a horizontal or sloping wire antenna. Perhaps the most familiar multi band wire aerial is the trap dipole. The traps, in simplest terms, divide a wire dipole into two or more resonant sections so that two or more bands can be covered.

As far as commercial options go then there are quite a number. Tony Nailer of Spectrum Communications produces a great deal of useful equipment and accessories including some well designed and well made trapped dipole aerials based on the very effective W3DZZ design. In particular the Full Size G4CFY resonant on 80m and 40m and also allowing operation on 20m, 15m and 10m, also the Half Size G4CFY resonant on 40m and 20m and additionally allowing operation on 15m and 10m.

Visit http://www.spectrumcomms.co.uk/G2DYM.htm for more information.



Spectrum Communications G4CFY Trapped Dipole
http://www.spectrumcomms.co.uk

Spectrum Communications G4CFY Trapped Dipole
http://www.spectrumcomms.co.uk

More about Coaxial Trapped Dipoles

A trapped dipole for 40m and 80m offers the advantage of being somewhat shorter than a full size single band 80m resonant dipole plus it offers 40m as a resonant band plus the possibility of working on 20m, 15m and 10m. There are several designs available on the web for this type of aerial so Google W3DZZ. One of the most comprehensive sets of instructions is by Len Paget G0ONX. Fine out more here:
http://www.users.icscotland.net/~len.paget/GM0ONX%20trap%20dipole.pdf

This would be my choice if I had the space, though since a dipole is a balanced aerial it would make more sense to use balanced twin feeder (as in the Spectrum Communications implementation of this design) rather than coaxial cable which is an un-balanced and more lossy feeder.

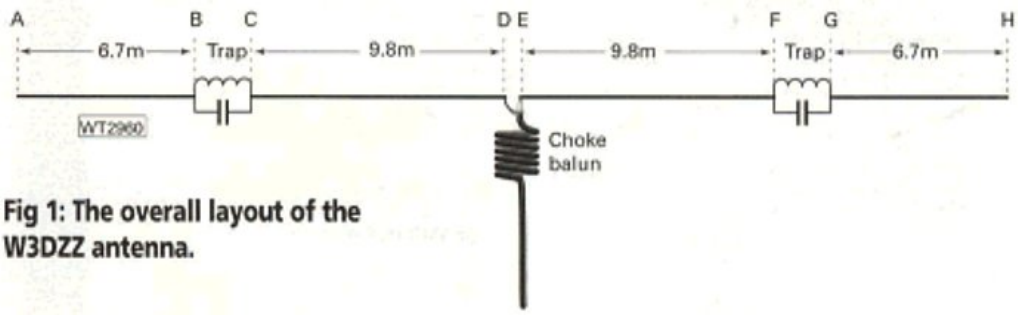
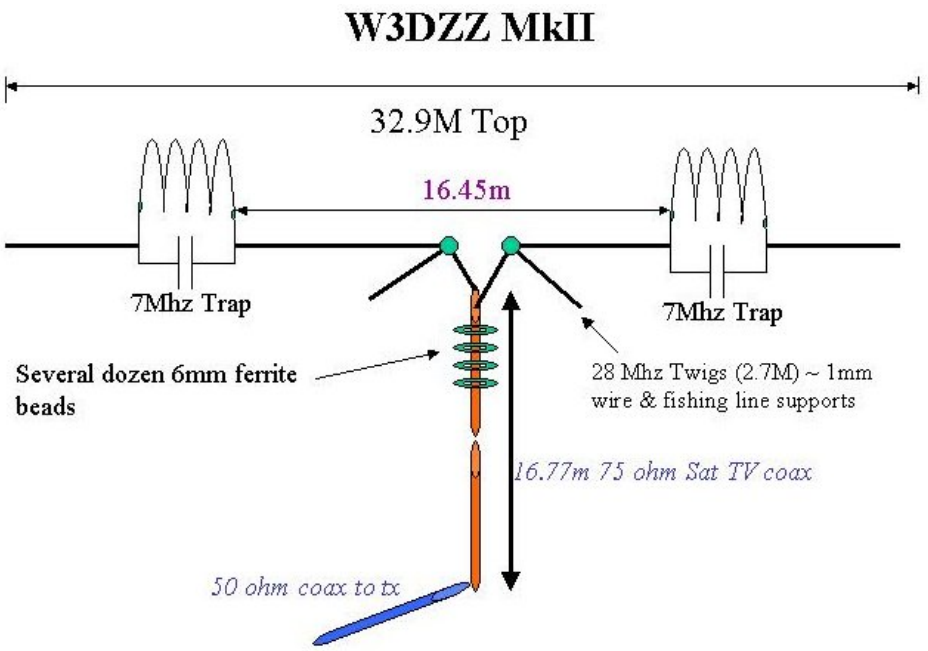


Fig 1: The overall layout of the W3DZZ antenna.

The W3DZZ Trapped Dipole - a balanced aerial, so use balanced twin feeder!

Here is a variation on the W3DZZ antenna by the Maidstone Amateur Radio Society that adds a dedicated 10 meter (28MHz) resonant element as a 'fan'.



W3DZZ Dipole Aerial design by the Maidstone Amateur Radio Society
http://www.btinternet.com/~shaun.scannell/club/w3dzz.htm

Moonraker supply a whole range of wire trap dipoles covering from 2 to 5 HF bands (MTD1; MTD2; MTD3; MTD4; MTD5; MTD6). Diamond also produce trapped wire antennas, the W-721, W-728 and W735. Comet and Diamond each produce similar interesting 5 band wire dipoles that utilize both traps and a fan arrangement - the Diamond W8010 and the Comet CWA-1000. If space really is limited then look out for KZJ Communications (dongo1950 on ebay) - he produces 'Limited Space Inductive Dipoles'. These are inductively loaded and shortened dipoles so they will have reduced efficiency, of course, but are very nicely made, so might be very useful in a tight spot.

Alpha Delta Communications produce a couple of substantial parallel dipole models: http://www.alphadeltacom.com

To obtain good efficiency and achieve a low angle of radiation, desirable for longer distance DX, a horizontal dipole needs to be installed at a good height - over 20 feet would be desirable and it is quite common to install horizontal dipoles at around 30 to 40 feet above ground level. This might be a problem at some QTH's, it certainly is at mine!

Allan Copland, GM1SXX comments: "The dipole will operate well on the band it has been sized for , if placed at a suitable height, but will also operate as a' three-half-wave' aerial at three times the frequency and so on, so it's not strictly a single band aerial. An 80M dipole (132 feet typical) will work nicely on 30 metres (three half waves) but not on 40m (two half waves)… because on 40M the feed-point is at a voltage node and not at a current node, for easy feeding. Most aerials are current fed.

The radiation pattern changes when a dipole is not used on its design frequency. The pattern will break up into multiple 'petals'. This can be either a disadvantage or an advantage depending on what you expect from it. Since most of us use co-ax, an UN-BAL should really be used to connect the unbalanced feeder to the balanced aerial, but how many people actually bother? Not many I suspect. It's possible of course to use a balanced feed-line system instead with a dipole and just have a delta match (no centre insulator… none needed). There are many choices and permutations, but in general, dipoles are centre fed at a point of current maximum (and minimum voltage).

A normal dipole is current fed but of course can be voltage fed instead. This is what's done in the EFHWA or Fuchs aerial where a resonant half wave wire is fed at one end (max voltage / min current) from an L/C tank, against a very short counterpoise wire.

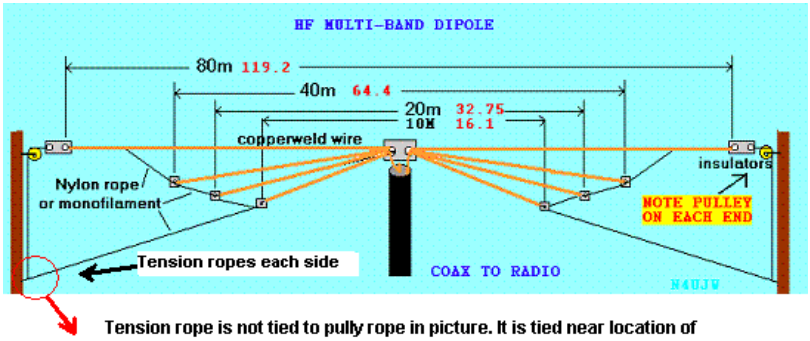
Fan Dipoles (a.k.a. Parallel) Dipoles:

Another design of multi band wire dipole is the fan dipole, or parallel dipole. A fan (or parallel) dipole will have, perhaps, two, three or four individual resonant dipoles with the arms arranged in a fan shape.

A fan dipole is a very handy way of using a dipole that will be resonant on several bands - typically three or four. The fan dipole (a.k.a. Parallel Dipole)

See M0WYM's page for a QRP Fan Dipole design: http://www.radiowymsey.org/FanDipole/fandiploe.htm

See this page for construction details: http://www.hamuniverse.com/multidipole.html

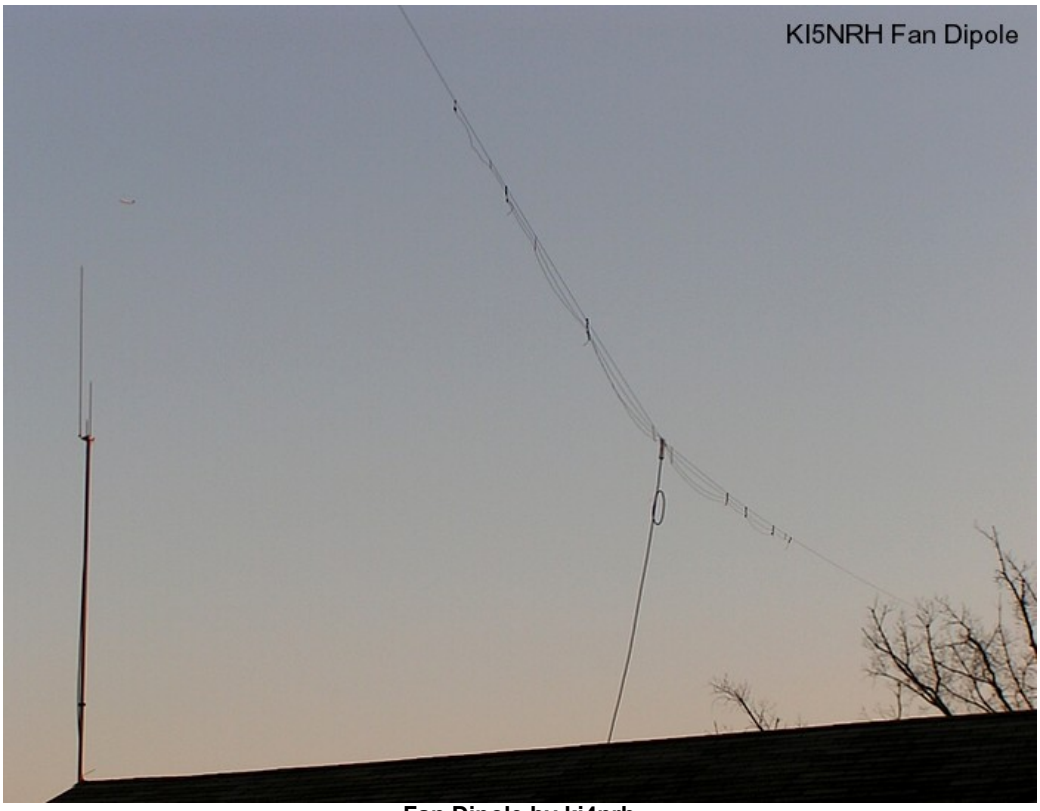


Tension rope is not tied to pully rope in picture. It is tied near location of pully rope down on supports within easy reach. It is tied last after final SWR adjustment and the antenna is in it's final position.

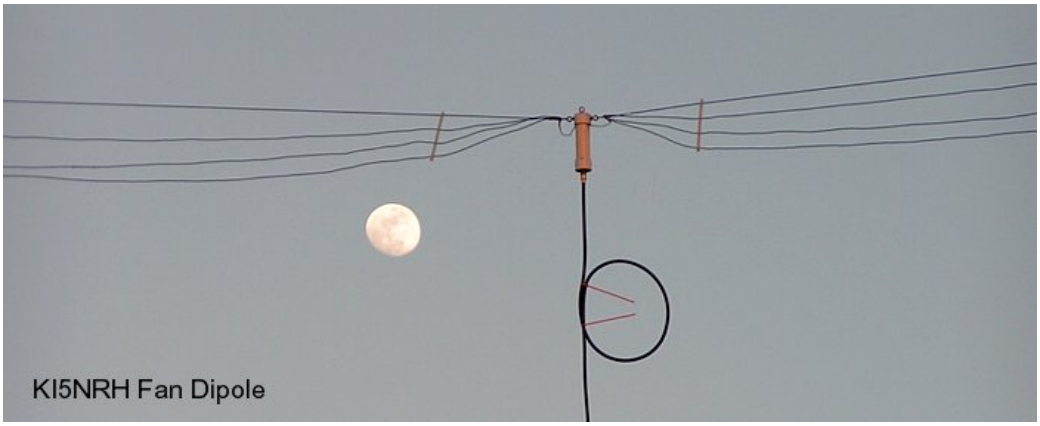
Suggested total lengths:
80 meters - 120 feet
40 meters - 65 to 66 feet
20 meters - 34 feet
10 meters - 17 feet
These lengths are not exact. Some tuning may be required. Use the standard formula 468 / freqmhz for total feet for each band (freq) of interest. Adjust each length longer or shorter as needed.

Fan Dipole shown on Ham Universe

KI4NRH built a really neat fan dipole shown in the photograph below:



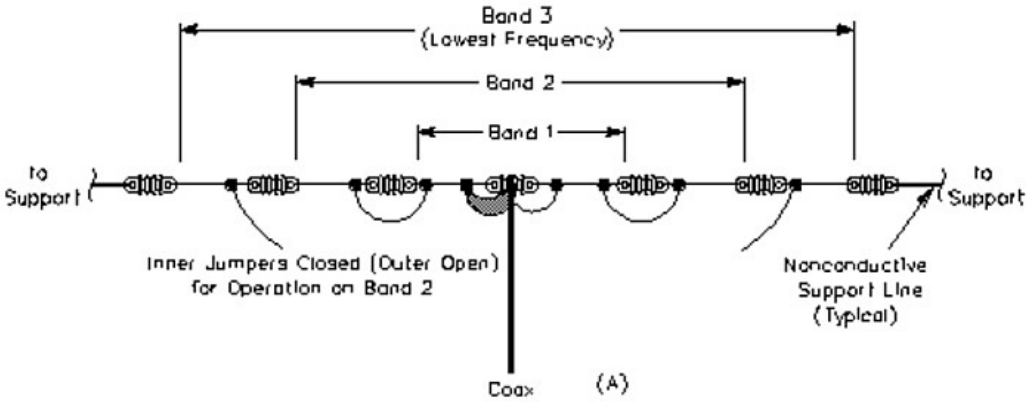
Fan Dipole by ki4nrh



Fan Dipole by ki4nrh
http://forums.qrz.com/showthread.php?t=159953

Link Dipoles

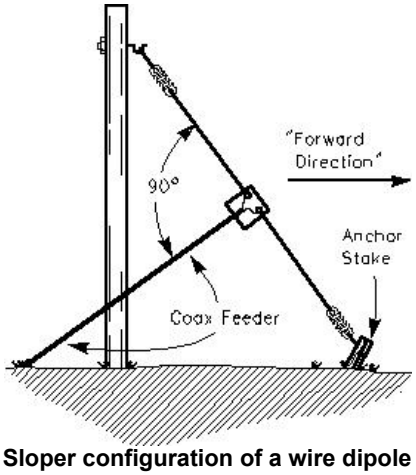
Link Dipoles (a.k.a Jumpered Dipoles) facilitate multi band operation by simply connecting the jumpers (one on each side of the aerial) to achieve the desired resonant band. Perhaps a bit bothersome for frequent band changes, but a very simple and effective aerial and very handy for portable operation, not to mention efficient for QRP.



Link Dipole - ref ARRL

Sloper Aerials

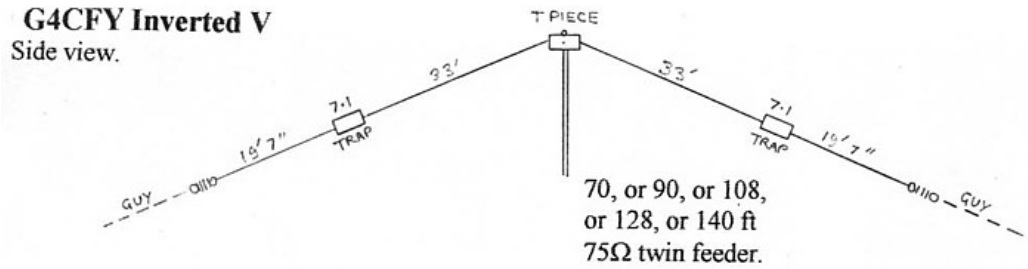
Alternatively a dipole can be installed as a sloper; one end fixed to a high point on the house or building, or a tall post maybe 8 to 10 metres high, with the other end attached to a lower point such as a post maybe 3 or 4 metres high. This will give the aerial some directivity.



Sloper configuration of a wire dipole

Inverted V Aerials

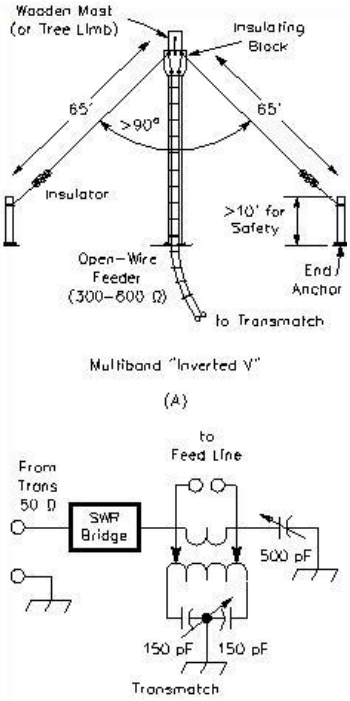
Another option maybe to support the dipole at its centre on a tall pole, or roof apex, with each end sloping downwards to lower fixing points. This will give the aerial an upside down V shape. As with a sloper, the Inverted V arrangement will give the aerial some directivity - a different radiation pattern compared to a straight horizontal dipole.



Spectrum Communications G4CFY Trapped Dipole in "Inverted V" configuration
http://www.spectrumcomms.co.uk

The Classic Doublet Antenna Again. This time in an Inverted V formation:

Using an Inverted V can help fit a dipole into a slightly restricted space. The Inverted V arrangement can be used for single band resonant dipoles, trapped dipoles and fan dipoles. The Doublet must be fed with Ladder Line or Open Wire balanced feeder for efficient Multi-Band operation.

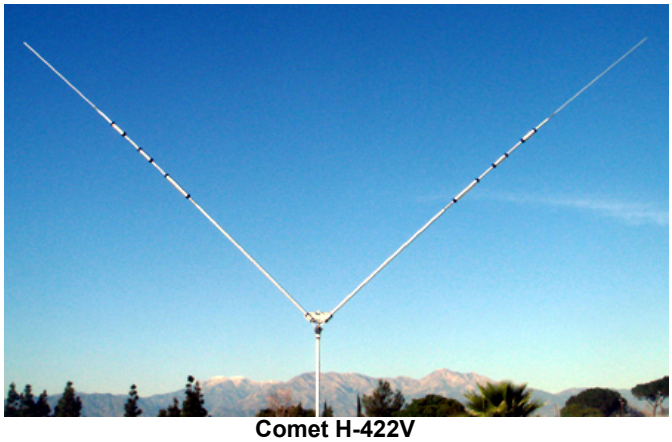


At A, details for an inverted V fed with open-wire line for multi-band HF operation. A Transmatch is shown at B, suitable for matching the antenna to the transmitter over a wide frequency range. The included angle between the two legs should be greater than 90° for best performance. [ref: QSL.net]

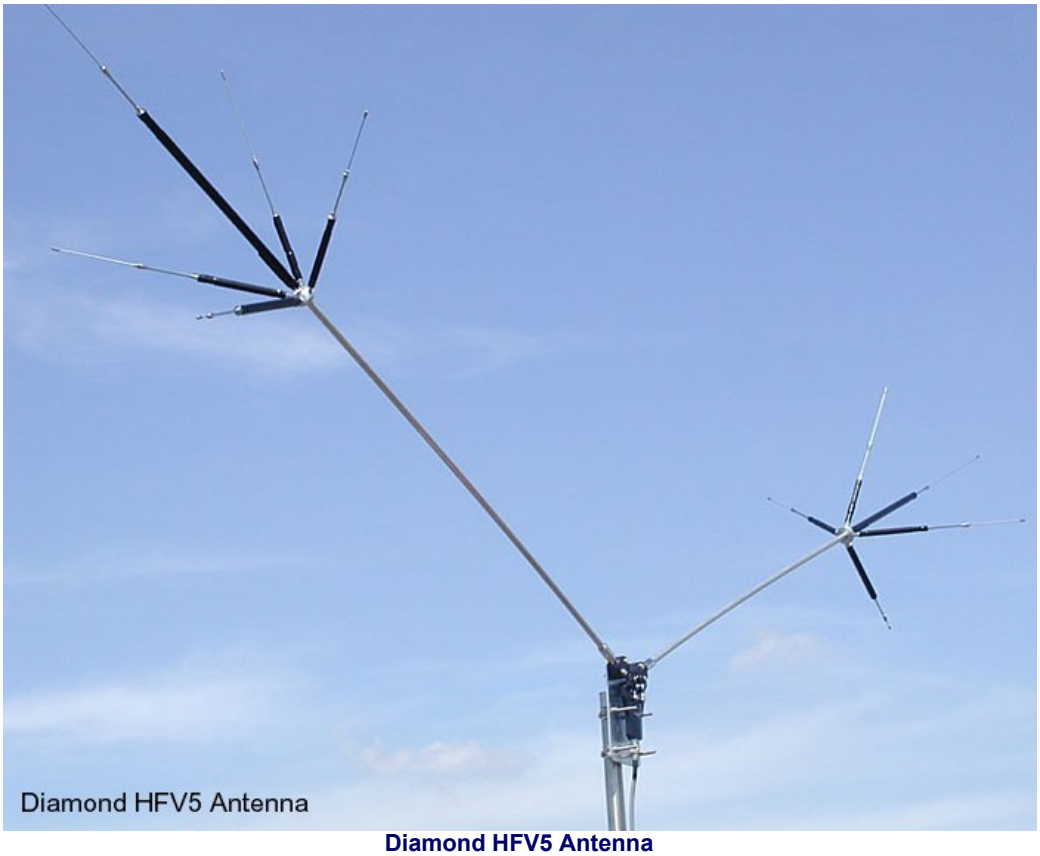
Vee Configuration

Comet and Diamond produce Vee antennas that can be mounted on the side of a building at roof height, or on a pole, telescopic pole or other suitable support. These are trapped dipoles in an upright V configuration, not made of wire but of aluminium tubing for solid construction. Typically covering 40m, 20m, 15m and 10m. The Comet model is H-422V. The Diamond Model is HFV5 which also covers 6m.

These are shortened antennas so cannot be expected to have high performance on the lower HF bands, but if space is restricted the RF compromise may one that has to be taken.

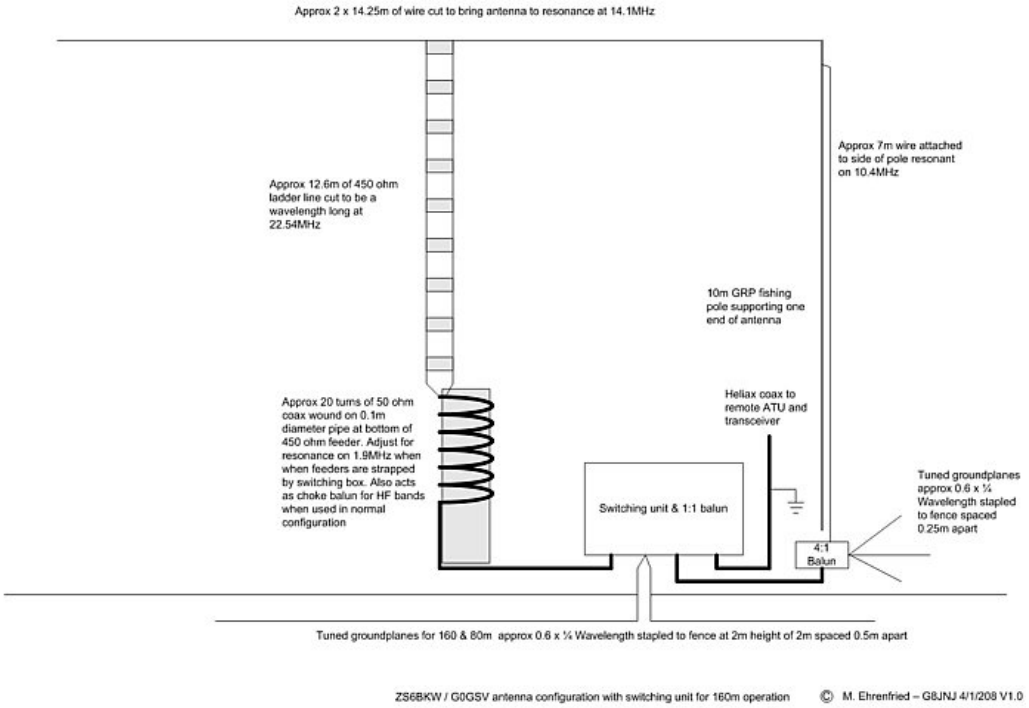


Comet H-422V
http://www.cometantenna.com



Diamond HFV5 Antenna
http://www.diamond-ant.co.jp/english/amateur/antenna/ante_2base/ante_base7.html

Thoughts from Martin G8JNJ on multi-band wire antennas:



Multiband Wire Antenna by Martin G8JNJ
http://g8jnj.webs.com/

Linear Loading

Linear loading a dipole can reduce the length to help fit a ling dipole into a shorted space by essentially folding back some of the dipole elements. Here is a design by K4VX for a 7MHz Linear Loaded Dipole:
http://www.arrl.org/files/file/Technology/tis/info/pdf/0207040.pdf

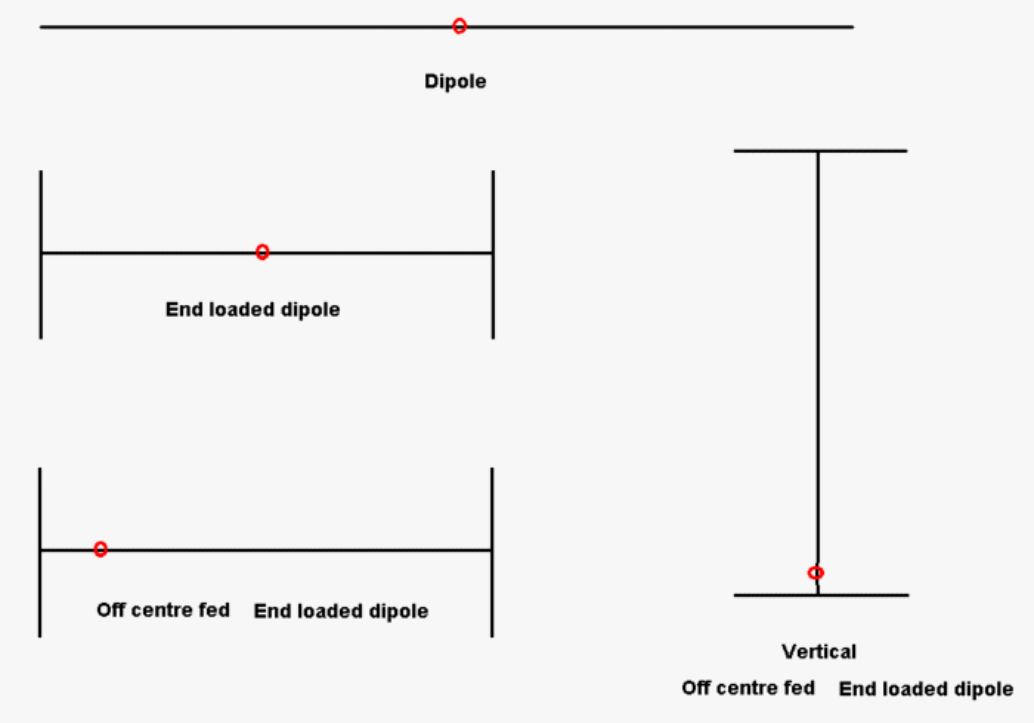
End Loaded Dipole

End loading can also help reduce the size of antennas, particularly useful for dipoles used on the 80m and 160m bands.

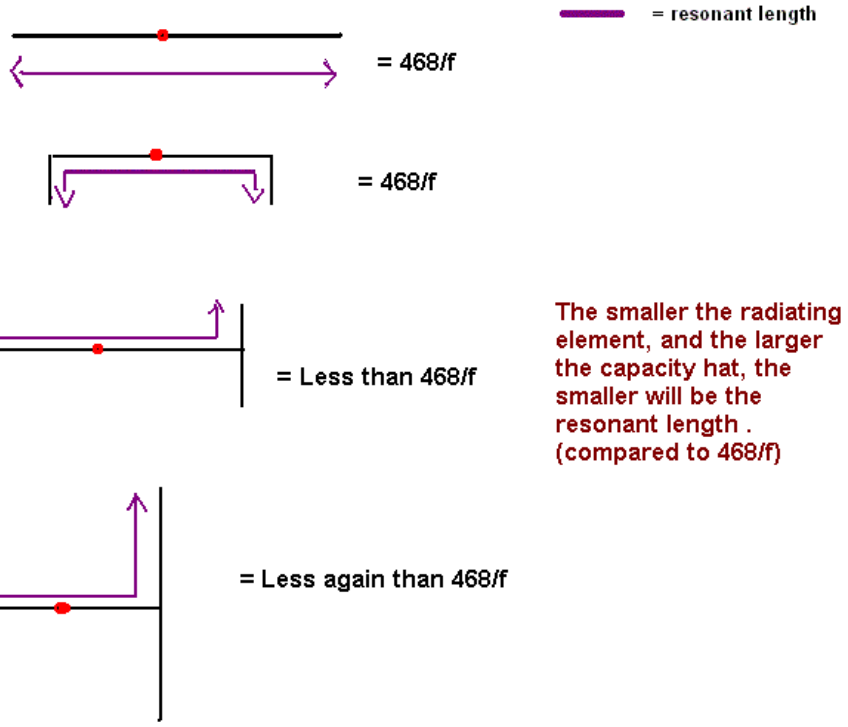
An end loaded dipole will produce an antenna that is H shaped. There are several commercial designs available produced in designs that cover a single band and others that cover multiple bands. The version shown below is only 3 metres tall so will be suitable for very unobtrusive, low profile use. It is the ProAntennas Multi-band I-PRO: 20m 17m 15m 12m 11m & 10m which uses a capacity hat with some loading at the centre.
http://www.proantennas.co.uk/

Other similar antennas were available from Force12 Antennas in the form of, amongst others, the Sigma 5 and Sigma GT5. The Sigma design used T-bars at each end of the vertical dipole for loading technique and off-center loading coils. http://www.force12inc.com This was supplied supplied in the UK by Vine Antennas at one time http://www.vinecom.co.uk . Transworld Antennas also have produce antennaa using a similar concept - the TW2010 Adventurer and Backpacker http://transworldantennas.com

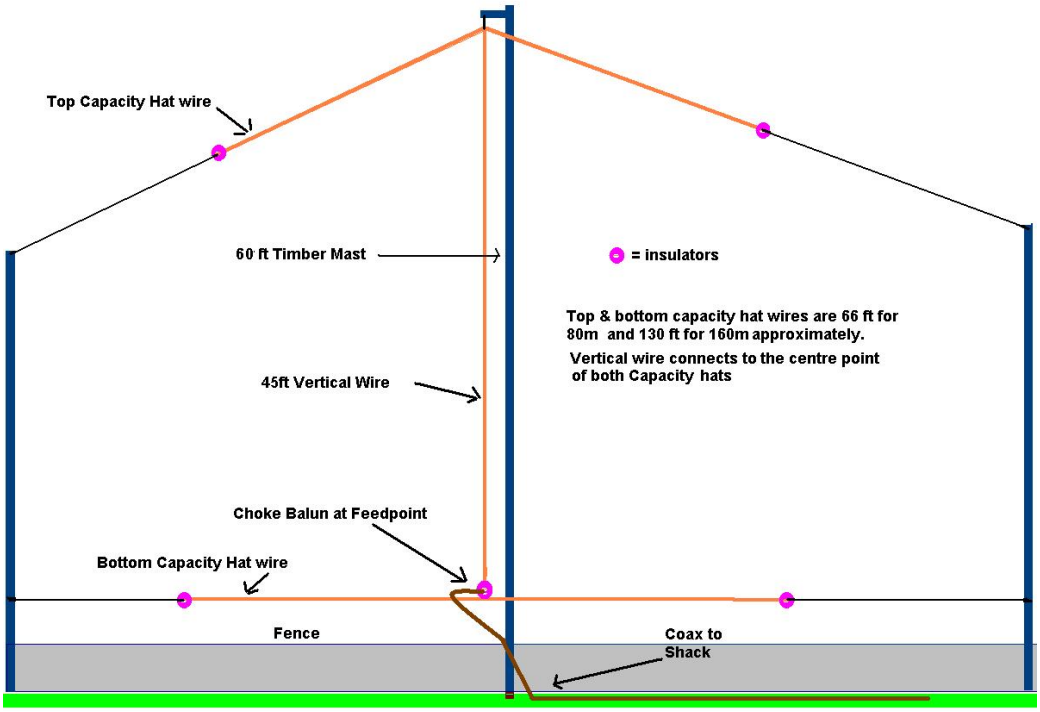
K9AY Notes that: "I have come to the conclusion from my experiments, readings and observations, that a capacity hatted vertical dipole, a few feet over ground, is less compromised than a 1/4 w/l vertical of the same height fed against a less than perfect ground. Let's face it, most amateur's ground systems are mediocre at best. Also, the dipole is easier and cheaper to rig, and is two dimensional..Very important in my situation, as I cannot run out radials on my neighbours property. Or, to quote W4RNL.."Since only a handful of hams can ever have 160-meter antennas high enough to yield a low angle DX signal, more practical are vertical arrays such as yours. Vertical dipoles with hats (or Tees) save a plethora of wire needed by monopoles." http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7466



Information by K9AY



Information by K9AY

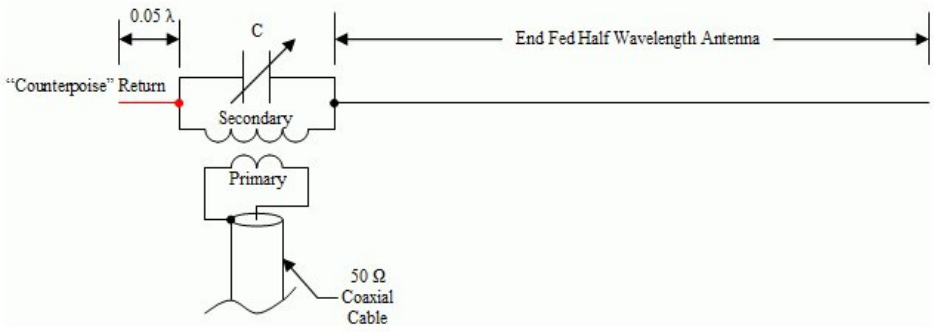


Interesting concepts from K9AY

End Fed Half Wave Antenna

The End Fed Half Wave Antenna (EFHWA) is fed at a voltage node via a parallel resonant circuit against a 'short counterpoise', it is a favourite of backpackers and outdoor types. It can be considered as a half wave dipole that's end-fed at a voltage node rather than the current node, as is more usual. This is a very handy arrangement for portable QRP work.

EFHWA Link: http://www.aa5tb.com/efha.html



End Fed Half Wave Antenna by AA5TB
http://www.aa5tb.com/efha.html

"I suspect that nothing new or radical has happened in the field of radio aerials in a VERY long time, like at least many tens of decades. Most of the new wonder aerials are really a con. Choke off the feed-line and then see how good they really are. Prime among the baddies is the CFA. It doesn't really work, at least if you place a choke in the feed-line. With any real aerial, there should be minimal radiation from the feed system… so a choke should really make no difference at all, but for the CFA it does! The CFA is not alone, there are others. The popular G5RV is another design with a radiating feed, deliberately so, but of course G5RV planned it that way. He wasn't cheating… merely being a bit devious, to make it multi-band".

"Lots of stuff to pass on to my fellow radio club members, most of whom are of the 'if it's not expensive, it can't be any good' school of thought when it comes to aerials. Nothing of course could be further from the truth! Aerials are one area where it makes a lot of sense to build our own." : Website of GM1SXX - www.observations.biz

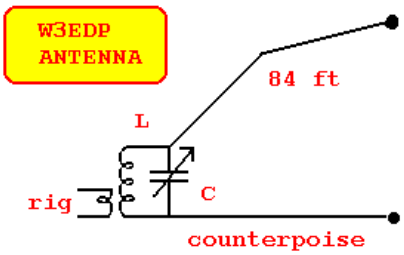
Thanks for your email Allan. It's a good idea to point out that an antenna could be pressed into use on odd multiples of its resonant frequency, hence a 3.6MHz antenna for 80m could be useful near the 30 metre, 10.1MHz, band - near to the third harmonic of 3.5 MHz although, as you observe, the radiation pattern may be quite distorted from the traditionally expected dipole pattern and be more petal shaped. The same goes for a 7.1 MHz antenna for 40m being usable on its third harmonic of 21.3 MHz for the 15m band - a 40m dipole being three half waves an the 21 MHz band.

I have not experimented with a full size 80m dipole, but I would guess that it might be useful at 5 times 3.6Mhz in the 18 MHz / 17m band?

The point made about feeding a familiar dipole at the current node rather than the voltage node is obviously very important and, I imagine, sometimes overlooked.

PLANS: Download the pdf plans produced by G0KYA here > http://g0kya.blogspot.com More from G0KYA here:

W3EDP Antenna



Frank, G3YCC comments on his website: The W3EDP needs a simple matching unit is needed to couple the wire to the rig and a counterpoise is required for some bands, however there is room for experimentation. It has been shown that different lengths or removal of the counterpoise altogether, can improve performance, as described in RadCom, August 1996 by G3LCK.

The Tuning capacitor in the AMU can be a 365 - 500pF broadcast type or a miniature version is OK for QRP use.

Counterpoise lengths: 3.5 & 7.0Mhz - 17ft ; 14Mhz - 6.5ft ; 28Mhz - none

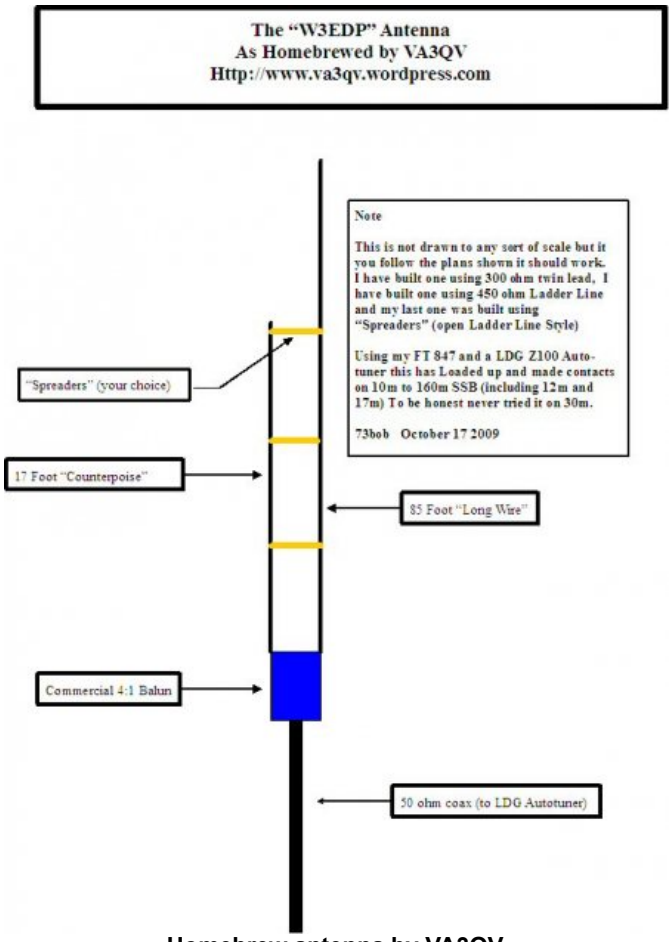
Tuning Unit: Values for coils in the unit, based on a 2 inch former and 16 swg wire:
3.5Mhz 21 turns ; 7.0Mhz 7 turns ; 14.0Mhz - 5 turns.

K3HRN Notes: "Some folks have told me the modifications below make the antenna something other than a W3EDP. I can tell you that it works very well with 5 watts. Create a "bundle" of counterpoise wires, 1/4 wave length for each band you will use. Attach the bundle to the tuner in place of the counterpoise pictured above. Be cautious, 1/4 wave length elements can have high RF voltages present, even at QRP power levels. I've been able to work 160-10, including WARC bands with this type of antenna".

W3EDP or Zepp ?

It's the antenna favoured by VA3QV for all band Portable QRP operating!

VA3QV uses this home-brewed antenna with a small LDG Z100 antenna tuner for portable QRP work.



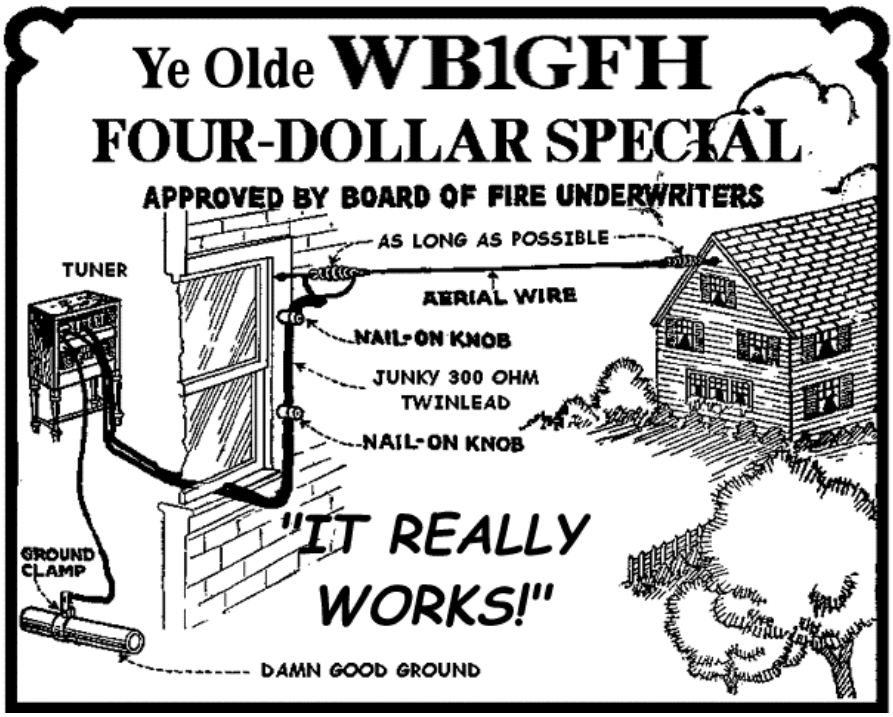
Homebrew antenna by VA3QV
http://va3qv.wordpress.com

Ye Olde Zepp

Marconi spins in his grave every time a ham buys an aerial instead of building it ! (W1GFH)

Here is a wonderful olde worlde style cartoon from WB1GFH that certainly inspires antenna experimentation with

antenna designs:

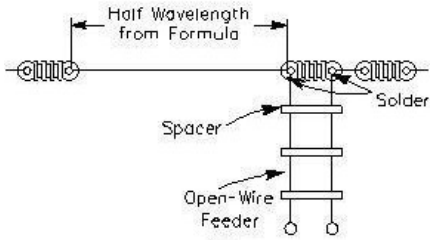


Superb. I love it!

See more inspiration from Joe Tyburczy, W1GFH, here: http://www.hamuniverse.com/fourdollarspecialw1gfh.html

End Fed Zepp "Zepp"

The End Fed Zepp consists of a 1/2 wavelength horizontal radiator wire connected to one conductor of a length of parallel open wire feeder, 300 ohm or 450 ohm twin feeder. The feeder is often quoted as being 1/4 wavelength long.

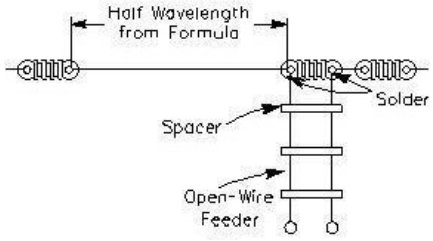


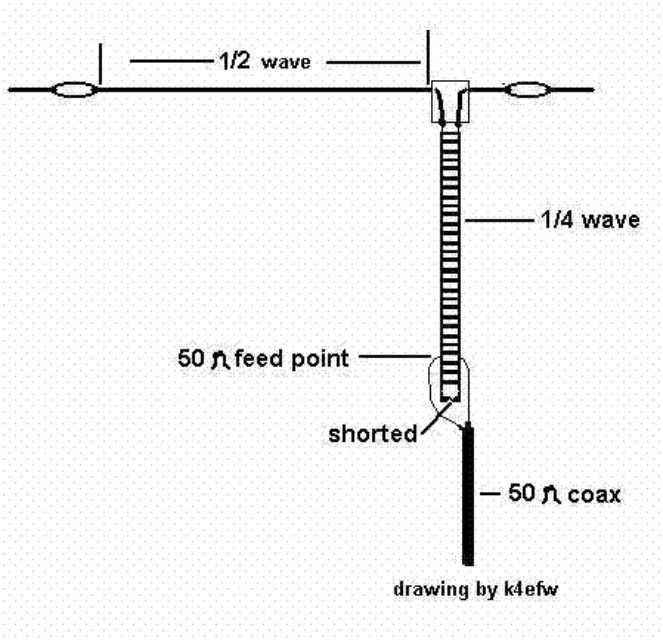
Basic design of an end fed Zepp

G Whip Antenna Products manufacture and supply a version of the Zepp antenna. Geoff G4ICD explains: "The end fed Zepp shown below has no counterpoise, just a tuned circuit in the feedpoint plus a half wave radiator. This is a most interesting antenna and can be used on other bands with the use of an Antenna Matching Unit."

A high quality End Fed Zepp style antenna: This variation uses a tuned circuit rather than a tuned twin feeder.
Supplied by G Whip Antenna Products of the UK
www.gwhip.co.uk

The end fed zepp is a popular antenna often used to save space and gets its name from the fact that it was used as an end fed wire trailing out from the rear of Zeppelin airships. It consists of a 1/2 wavelength horizontal radiator wire connected to one conductor of a length of parallel 300 ohm or 450 ohm twin feeder, often quoted as being 1/4 wavelength long.





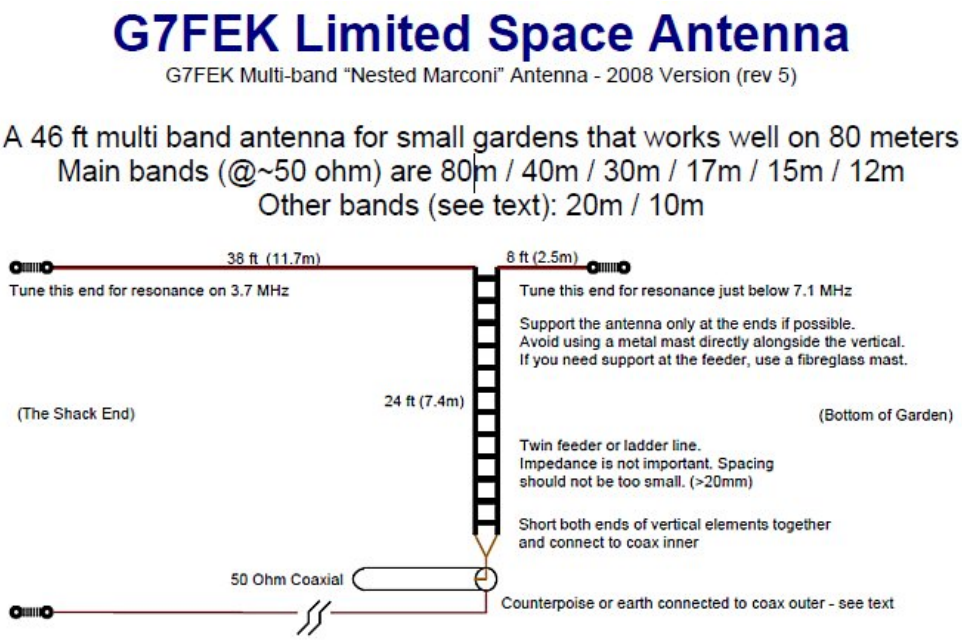
Zepp Antenna by K4EFW
http://www.hamuniverse.com/n4jaantennabook.html

K4EFW notes: "...A half-wave resonant antenna can be fed from its end. When fed this way, it is also known as an end-fed zepp. An end-fed zepp will work on its fundamental frequency and on odd and even harmonic frequencies. The end of a half-wave antenna has very high impedance, and an antenna fed this way is said to be voltage fed. Feeding a half-wave resonant dipole in the center means it is current fed. The normal way of feeding the end-fed antenna is with ladder-line. One side of the ladder-line is connected to one end of the antenna and the other side of the ladder-line is connected to nothing. To secure the unconnected side of the ladder-line, it is connected to a short wire running between two insulators. Since the antenna is connected at its high impedance point, no current flows into an antenna, but there will be a large current in the center of this antenna. No current flows from the open side of the feed-line because it is at a zero current point. The end-fed zepp can be matched by cutting the ladder-line to a quarter wavelength with the bottom end of the ladder-line shorted. A certain distance above the short is a 50-ohm feet-point and it can be fed directly with coax. You will have to find the 50-ohm point by trial and error. This method of feed makes it a single band antenna". Quoted from K4EFW.

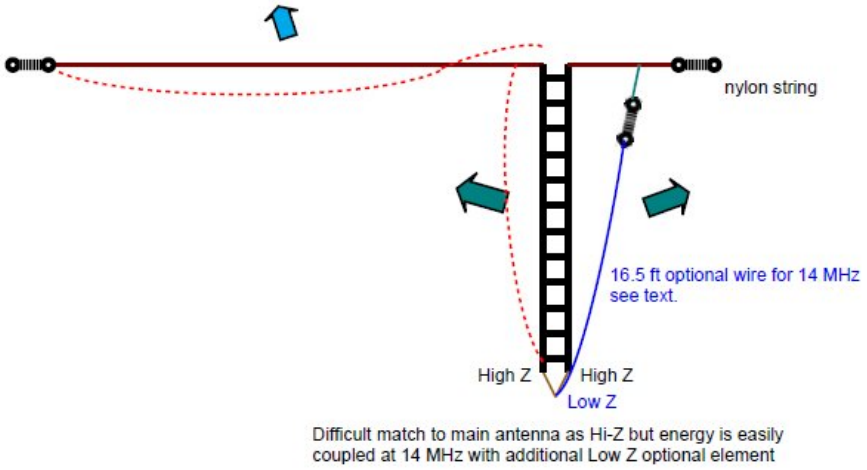
Here is a commercial product made by G-Whip Antennas of the UK offering their version of a Zepp antenna design: http://www.gwhip.co.uk/

Martin G8JNJ highlights a very interesting antenna designed by Mike G7FEK here:-

The G7FEK antenna goes several stages further than the simple single band End Fed Zepp. G7FEK has produced a design for Multi-Band operation claimed to offer much improved performance over a half sized G5RV or 'Windom' antenna while additionally providing access to the 80 Metre Band.



G7FEK Limited Space Multi-Band Antenna



Adding 14MHz to the G7FEK Limited Space Multi-Band Antenna

The G7FEK design will allow operation on 80m / 40m / 30m / 17m / 15m / 12m with the possibility to add the 20m band.

G7FEK Plans: Download the plans for the G7FEK antenna from G7FEK's website here or from this website here

Tuner Design For Half Wave Vertical and Similar Length End Fed Antennas by G4FGQ

http://www.radioaficion.com/HamNews/articles/8218-tuner-design-for-half-wave-vertical-a-similar-length-end-fed-antennas.html

Off Centre Fed Dipole (OCFD) - so called 'Windom' Antenna

The "Windom Antenna" was described by Loren G. Windom W8GZ. It could be an ideal wire aerial for use in restricted spaces for multi-band operation. It may also be an good candidate for portable work.

It is a wire antenna, similar to a dipole, but unlike a dipole or doublet which is fed at the exact centre, a Windom or Off Centre Fed Dipole, as the name suggests, has the feed point off center.

Current versions of the Windom are not actually Windom antennas at all - instead they are fed with coaxial cable and have a balun placed at the feed point. These are Off Centre Fed Dipole antennas - OCFD. They are similar in

appearance to a true wire Windom, but they are different.

As with all aerials the aerial should be as high as possible. With the feed point at between 20 and 40 feet above ground the typical claimed impedance will be somewhere in the region of 200 Ohms so a 4:1 balun will typically be required. At greater heights, and depending upon the exact position of the feed point, the impedance may be higher and a 5:1 or 6:1 balun might be a better choice although balun losses will be greater.

The point at which a Windom is fed in the original design, which used an open wire to feed the aerial, was 15 percent off-centre. The current designs, which are fed with coaxial cable, are typically fed about 33 percent off centre, so one leg is 67 percent of the total length and the other leg is 33 percent of the overall length of the aerial.

The bands that are covered depends upon the overall length of the aerial:

11 metres long (approx) should cover 20m, 15m and 10m and the WARC bands with a tuner.

21 metres long (approx) should cover 40m, 20m, 15m and the 10m bands and WARC with a tuner.

41 metres long (approx) should cover 80m, 40m, 20m, 15m and 10m and WARC with a tuner.

80 metres long (approx) should cover 160m, 80m, 40m, 20m, 15m and 10m and WARC with a tuner.

Cut the aerial for the lowest band to be used. In imperial measurements using a familiar formula:
The longer leg will be 468 divided by the frequency and multiplied by .67 = length in feet
The shorter leg will be 468 divided by the frequency and multiplied by .33 = length in feet

OCFD Formulas:

The offset proportions differ according to which sources one refers. Some sources suggest 33% / 67% but other dimensions are also to be found:

62.2% for one side and 37.8% for the other leg. So:
The longer leg will be 468 divided by the frequency and multiplied by .622 = length in feet
The shorter leg will be 468 divided by the frequency and multiplied by .378 = length in feet
[Source: New Caroline Windom - http://www.hamuniverse.com/k4iwlnewwindom.html]

Other ideas:

The proportions of 69% / 37% are used by Buxcomm who say that "One third plus two thirds will not work. Use the formula below, as is: Do not be concerned with the off-set of the feed point, as this formula takes into consideration, the correct off-set for feeding the (BUXCOMM) Windom.for the other leg." **So:**
The longer leg will be 468 divided by the frequency and multiplied by .69 = length in feet
The shorter leg will be 468 divided by the frequency and multiplied by .37 = length in feet
[Source Buxcom: http://www.buxcomm.com/windom_files/WINDOM.htm]

Given the fairly simple formula it should be quite easy to make an OCFD Windom - however a Windom can be purchased at very reasonable cost commercially, for example from M0CVO at http://m0cvoantennas.webs.com alternatively G-Whip Antennas of the UK supply extremely high quality, high efficiency 4:1 baluns (and other baluns) that could be used at the centre of any Off Centre Fed Dipole - just add the correct wire lengths to each side.

Geoff G4ICD / GJ4ICD of GWhip highlighted his website which has an interesting page with comments concerning the quality and construction of balun products. This feature on the G-Whip site can be seen here:
http://www.g4icd.co.uk/baluns.htm

Here is a photograph of the very high quality G-Whip OCFD antenna product www.gwhip.co.uk :

An 'Off Set Centre Dipole' - OSCD - Fed made by G Whip Antennas
G-Whip Antennas - www.gwhip.co.uk

HW-20HP Off Centre Fed Dipole - produced by M0CVO
6.76 metres long one side and 3.38 metres on the other side.
http://m0cvoantennas.webs.com

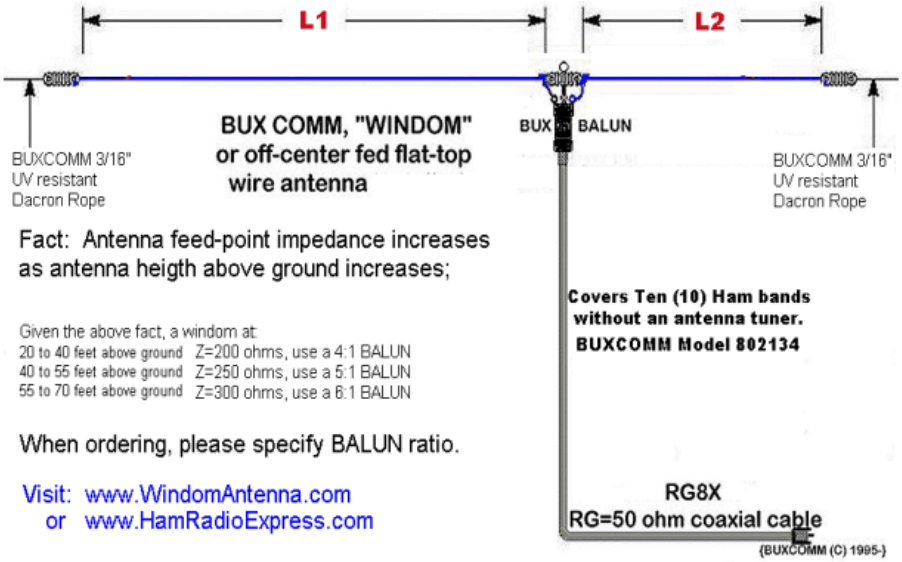
M0CVO produces a couple of off centre fed dipoles, the HW-40HP and the HW-20HP. Both antennas handle 400 watts - the HP designation refers to high power.

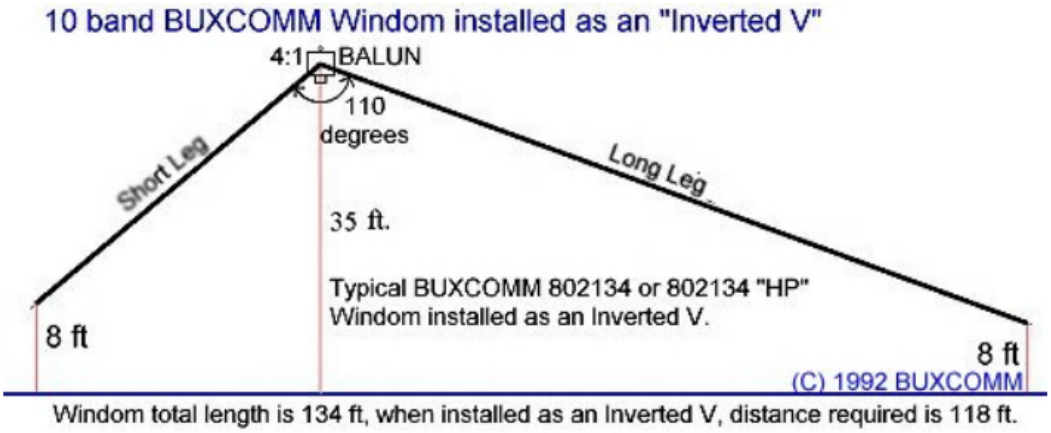
The M0CVO HW-20HP is 10.14m in length and covers 6 bands - 20, 17, 15, 12, 10 & 6m, no ATU, and is said to also work on 30m & 40m with an ATU. Can be mounted as a horizontal, inverted vee or a sloper. VSWR is said to be 1.4 on 20m, 2.8 on 17m, 1.1 on 15m, 1.0 on 12m, 1.0 on 10m and 1.5 on 6m. The antenna is6.76 metres long on one side and 3.38 metres long on the other side. This uses a 66.6% / 33.3% formula.

The HW-20P was reviewed by Steve Nichols, G0KYA, in the January 2012 edition of RadCom.

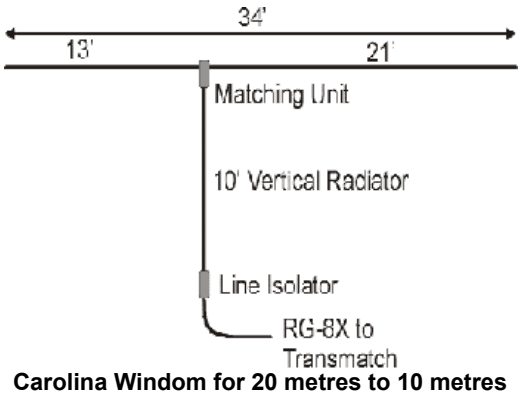
The HW-40HP is 20.28m in length and will operate on 40, 20 and 10m without an ATU and 80, 60, 15, 6 and WARC Bands with an ATU. (Presuably one leg is 13.52 metres long and the other 6.76 metres if it follows the same 66.6% / 33.3% formula as the HW-20HP).

Here is a graphic of an Off Centre Fed Dipole typical of those available in the USA:



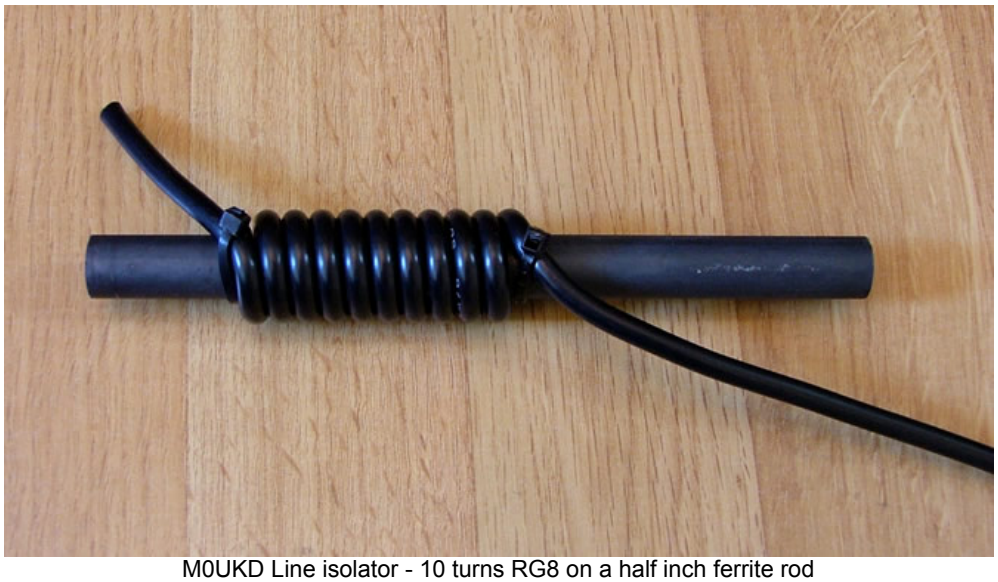


http://www.buxcomm.com

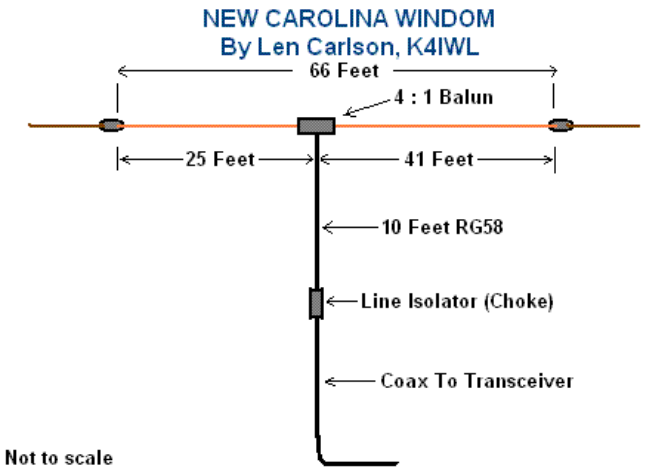


Carolina Windom for 20 metres to 10 metres
http://www.radioworks.com/ccwcover.html

M0UKD - 4:1 balun. It is 17 bifilar turns on a half inch ferrite rod. 50Ω - 200Ω, 1-30MHz
http://www.m0ukd.com/Carolina_Windom/index.php



M0UKD Line isolator - 10 turns RG8 on a half inch ferrite rod
http://www.m0ukd.com/Carolina_Windom/index.php



Windom design for 40m 20m 15m and 10m by K4IWL
http://www.hamuniverse.com/k4iwlnewwindom.html

More information on this general subject at BucksCom: http://www.packetradio.com/windom.htm **or** http://www.buckscom.com/pdfzips/windom.pdf

Commercial Suppliers:

G-WHIP Antennas (UK) : http://www.gwhip.co.uk
M0CVO OCFD Antennas (UK) : http://m0cvoantennas.webs.com

In the U.S.A:
Bux Comm Windom Antennas : http://www.buxcomm.com
Buck Master OFC Dipole Antennas : http://hamcall.net/
Alpha Delta : http://www.alphadeltacom.com
Carolina Windom : http://www.radioworks.com/ccwcover.html

See some Windom - Off Centre Fed Dipole - designs at these links:
http://users.erols.com/k3mt/windom/windom.htm
http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7478
http://www.radioelectronicschool.net/files/downloads/ocfdipole.pdf
http://www.hamuniverse.com/k4iwlnewwindom.html
http://www.g4nsj.co.uk/windom.shtml
http://www.m0ukd.com/Carolina_Windom/index.php

Semi-Permanent Antenna Installations

If it impossible to install a permanent aerial, then another option is to use an antenna designed for portable or mobile work deploying it only as and when necessary in the back yard or garden - perhaps supported with a portable tripod and/or guy ropes.

From the ideas above it should be possible to rig up a semi-permanent or removable antenna for low visual impact.

There are also very many portable antennas produced commercially that might be very useful to utilize on a semi-permanent basis. Commercially bought antennas can be very expensive indeed, especially when compared to 'home brew' aerials, but examples that immediately spring to mind for consideration include: The DMV-Pro, I-Pro, G Whip or G Whip Backpacker, the TW2010 from Transworld Antennas, the Sigma5 from Force 12 and aerials from SuperAntennas. Sandpiper Aerial Technology offer a very good choice of aerials such as the MV and MV-Portable, Buttie or Walkabout mk11 at very attractive prices. http://www.sandpiperaerials.co.uk There are very many other compact and portable antenna systems that are widely available. Check out all the amateur radio dealers for more ideas.

The DMV-Pro Antenna from ProAntennas (shown above) could be used in a back garden whenever required as could the company's I-Pro antenna. The DMV-Pro uses two fibreglass arms that allow the wire aerial to be supported in a number of different configurations such a "V" shaped, "L" shaped, "M" shaped and Delta. The aerial elements are fed to a 4:1 balun using low loss twin feeder, the balun is then connected to an auto ATU, such as the LDG Z-11 Pro, which is connected to the transceiver using coaxial cable. A versatile idea that could also be implemented on a DIY basis with a little experimentation! http://www.proantennas.co.uk

Geoff G4ICD / GJ4ICD mentions the original design, the JJ1VKL published in CQ ham radio Sep' 2000 in Japan. "This one goes back to 2000 and is now copied by several antenna manufacturers in the UK" It is an HF multi-band Delta loop antenna for 3.5-50MHz
http://www.geocities.jp/yoshiki_ja/deltae.htm

An Original Delta Loop design by JJ1VKL
Read more here: http://www.geocities.jp/yoshiki_ja/deltae.htm

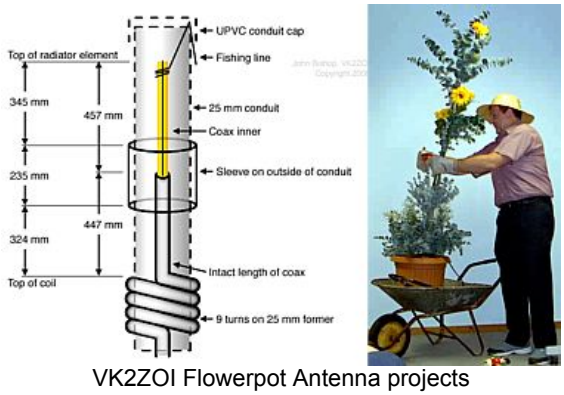
Delta Loop by Arthur M0PLK (SQ2PLK)
Details at http://pdxa.one.pl/articles.php?article_id=17
Available at http://ham-radio.urbasket.eu and http://www.vpa-systems.pl/

STEALTH / COVERT / HIDDEN or DISGUISED ANTENNAS:

Ideas from **G4ILO** - Stealth Antennas: http://www.g4ilo.com/stealth.html

VK2ZOI - "Flowerpot" Antennas

Some ideas by VK2ZOI about producing inconspicuous antennas - perhaps disguised as a plant in a flower pot! There are ideas for 6 metre, 2metre and 70cm antennas including a dual band 2,/70cm design.



VK2ZOI Flowerpot Antenna projects
http://vk2zoi.com

All Band HF Vertical Antennas (non resonant) - 'Untennas'

So this is where the search for a multi-band antenna begins. It's a difficult task especially if space is limited. First considerations might lie with the commercially available options that are available. Commercially manufactured aerials are available at widely varying price points - perhaps from under £100 to many many £100's

One of the first commercial multi-band antennas that many keen new amateurs come across is something like the Comet CHA250B, or the Diamond BB7V or Moonraker GP2500 (pictured right). These are broad-band antennas and look like large CB antennas with a matching network at the base. Such antennas claim to allow operation of all bands between 80 metres and 6 metres with acceptably low v.s.w.r. Sounds like the perfect multi-band solution, especially as Comet and Moonraker are well known names that make excellent products.

These multi-band antennas have their critics though: Sure enough, they exhibit a seemingly acceptably low v.s.w.r. across the whole of HF, but low v.s.w.r. isn't everything. Ctitics do, in fact, call these types of broadband antennas glorified dummy loads - a bit unfair possibly, but maybe they have a point when most of your transmitter's precious power is wasted as heat rather than radiated as a useful RF signal!

The only way a simple, single vertical radiator can be made to work on across such a wide range of frequencies is by having a broad band matching transformer at the base of the radiator. This will inevitably result in the absorption of some - or much of the transmitter's power - the power loss represented by the heating up of the coils/transformer rather than actually being radiated as a useful signal by the antenna's vertical element.

Such antennas could present a loss of around 6 - 12 dB compared to a resonant antenna - how do do fancy putting all 100 of your precious watts in to the antenna and only getting 6.31 watts of effective power radiated?

Maybe that's a bit simplistic, so Martin G8JNJ has many superb articles analyzing the CHA250B and similar antenna designs here: http://g8jnj.webs.com/cometcha250b.htm

The article Anatomy Of The Comet CHA250B by VK5ZBD can be found here:
http://www.radiomanual.info/schemi/ACC_antenna/Comet_CHA-250BX2_anatomy.pdf
(Formerly found at this site http://www.vk5zdb.com/CHA250BXII.htm)

G8JNJ is also developing a better version of this type of antenna here:
http://g8jnj.webs.com/broadbandhfvertical.htm

I admit that, due to limited space, I considered this type of antenna when first starting out - but in the end dismissed them due to the extreme inefficiency and power loss problems. They should not be entirely discounted however, because if this really is all that can be accommodated at one's QTH then at least such an aerial will at get you on the air - and on all bands - at least in some sort of fashion. Many amateurs use these aerials with success, so they do have a place. Have a look and decide for yourself.

Other similar types of broad-band antenna:

There are a number of very similar designs (i.e. longish vertical radiator, with a transformer / unun at the base) available from some other British suppliers:

The G Pro-Whip 'Widebander' antenna (see http://www.gwhip.co.uk/);
The ProWhip Portable Antenna (see http://www.prowhipantennas.co.uk/);
Snowdonia Radio Company (SRC) - various types of wideband antennas (see http://www.snowdonia-radio-company.co.uk)

All these antennas appear to be based around an UNUN (typically 9:1) matching transformer at the base of the aerial. These aerials cost considerably less than those previously mentioned. The G Pro Whip and Pro Whip Portable offer particularly convenient portable operating opportunities as they are based on one of my favourite methods of antenna support - a long telescopic fibreglass (fishing) pole. Really neat!

For the 'fishing pole' types, essentially there is a vertical radiating wire of about 7 to 10 meters long, a 10m long horizontal counterpoise wire and the 9:1 unun at the base. This makes for a simple and attractive installation proposition (but remember the penalty of power losses) - all these aerials will be easy to install for permanent, semi-permanent use and easily removable or portable operating.

Considering the 10 meter vertical type, the performance on 40 meters (1/4 wave) should be quite reasonable, with reduced performance on other bands.

G-WHIP G Pro Whip antennas (now discontinued)
by Geoff Brown G4ICD
2011/2 - See G-WHIP'S WideBander Antenna as an alternative
http://www.gwhip.co.uk/

Buy (or build) a 9:1 UNUN and Make Your Own:

If you already have a 10m telescopic fibreglass fishing pole and some wire, then you could easily wind a 9:1 unun, or even buy one from suppliers such as G WHip Antenna products for a reasonable cost. So, you could make your own aerial with 10m vertical radiator working against the 10m counterpoise and fed to the ATU via the 9:1 unun at the aerial's base - just for fun, for experimentation, analysis or for permanent installation or portable work. (The telescopic pole must be fibreglass not carbon fibre)

Martin G8JNJ, suggests that a slightly better way to home-brew a broadband HF aerial might be to cut a vertical aerial for about 8.5 MHz, i.e. not a resonant 1/4 wave on any amateur band, but optimised to present a moderate impedance on as many bands as possible. In which case the vertical wire would be about 8.8 metres long, working against the counterpoise, and fed to the a.t.u. via an unun - perhaps 6:1 or 9:1 - this is all open to further research and experimentation! See http://g8jnj.webs.com/currentprojects.htm

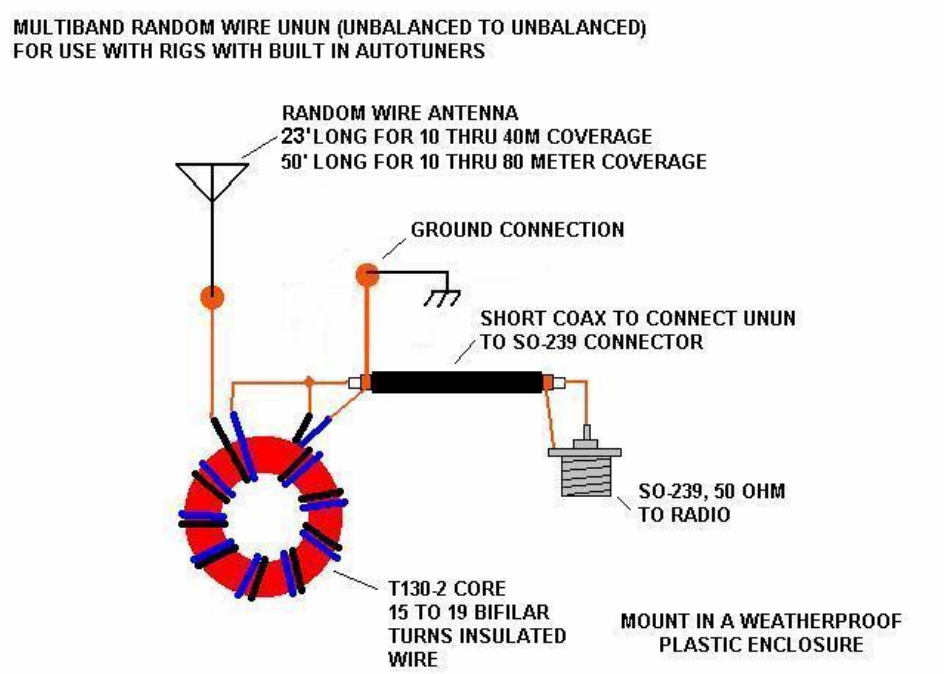
G0KYA has also written lots of interesting articles about antennas and several pieces about using a 9:1 unun and a length of wire. He found that a wire length of 19.8 metres offered a good compromise for a multi band aerial. Read G0KYA's blog here: http://g0kya.blogspot.com/search/label/antennas

More : http://g0kya.blogspot.co.uk/search/label/antennas

Interestingly 2W0SAK of Snowdonia Radio Company recommended an antenna wire length of 7.13 metres with their 9:1 unun - or for better efficiency a wire that is 19.8 metres long which would be run out horizontally. Both the 7.13 m and 19.8 metre lengths should cover the 80m to 10m bands.

Freq Coverage	Wire Length	or try
7 - 29 (50) MHz	2.74 m	6 m
3.5 - 29 (50) Mhz	7.13 m	9.8 m or 16.1 m
3.5 - 29 (50) MHz	19.8 m	21.9 m or 26.8 m
1.8 - 29 MHz	29.0 m	29.9 m
1.8 - 29 (50) MHz	39.6 m	36.6 m

High Quality Baluns and UnUns Available From www.gwhip.co.uk - either boxed and ready to use or just the core and quality windings suitable to put into own box or project.

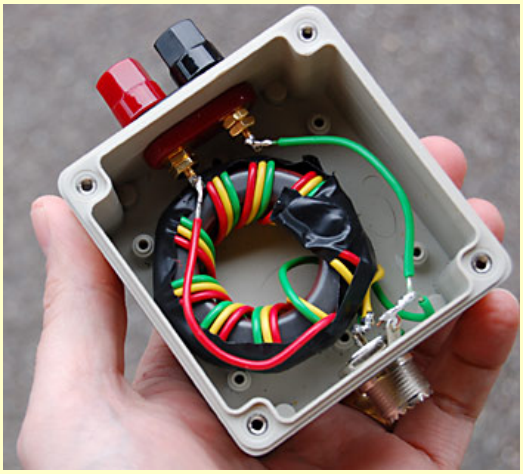


Above is a neat design for an "Untenna" KC8AON - Link: http://www.angelfire.com/electronic2/qrp/unun.html

For a jack of all trades try a high quality GWhip "Widebander Antenna"

G0KYA writes a very useful piece in his blog:

http://g0kya.blogspot.com/search/label/antennas



In the next round of tests I used the same 9:1 Un-Un wound using PVC covered cable and a T200-2 toroid. Note in the photograph that the PVC tape is only used to keep the turns neatly arranged.

If you want to build your own follow these instructions:

Building a 9:1 unun
To understand how to construct an unun lets build a 9:1 version. You will need a T-200 (red) toroid and three pieces of wire, each 24 inches (60cm) long . It will also help if you a small plastic box with an SO239 socket mounted at one end and with two wing nuts or mounting posts at the other. In the UK you can buy a small plastic box from Maplin which is watertight with a rubber seal, yet inexpensive.
It will help if the wires are different colours, although that isn't critical if you have a multimeter available. It just makes it a lot easier to follow these instructions.
For the sake of this explanation I'll assume that you are using green, red and black pieces of wire.
Put the three pieces of wire together and wind them carefully onto the T130-2 toroid. Place the wires (left to right) green-black-red, and wrap nine turns on to the toroid.
Try not to let the wires overlap.
You should end up with a toroid with three wires extending from the left winding and three wires extending from the right.
Now twist and solder the left black wire with the right red wire. This can be covered with PVC tape once complete.
Now twist the left green wire with the right black wire. Strip the ends of the two wires, twist and solder them together leaving the length about 2” long from the toroid.
Finally trim and strip the remaining right green wire and solder another 5” piece of green solid wire to it.
Now take the left green wire and right black wires that you twisted together and connect them to the centre pin of the SO239 socket – this is the input side and will connect to your radio via a length of coax.
One of the green wires is now soldered to the ground connection of the SO239 socket. The other end of the wire you soldered on (which is connected to it) becomes the earth connection for the unun and typically goes to a ground stake and ground radials.
This leaves the remaining red wire which connects to the other wingnut and will become the connection for the antenna.
If you are worried about the wires unravelling you can either use PVC tape to hold them in place or plastic cable ties.
So how do we use an unun? Lets look at a typical example.

This time I erected a 10m high fishing pole and attached a 65ft quarter wave antenna for 80m in an inverted L fashion. That is, 10m up and then 9.8m out to the nearby summerhouse.

This was arranged away from the house and fed with 12m of RG8 coax, a single earth stake and two 20ft radials at the feed point..

Here are the SWR readings at the end of the coax:
3.5MHz – SWR 3:1
3.65MHz – SWR 4.2
3.8MHz – SWR 5.9
7.10MHz - SWR 13.6:1
10.1MHz – SWR 2.5:1
14.2MHz – SWR 3.3:1

18.14MHz – SWR 1.8:1
21.2MHz – SWR 2.4:1
24.9MHz – SWR 1.9:1
28.5MHz – SWR 1.2:1

From this you can see that by shortening the wire to 65ft from the original 85ft you gain 80m, but lose 40m. The rig (FT2000) would quite happily tune seven bands with its internal ATU. Here are the quick comparison results against my 80m Windom and parallel-fed dipoles in the loft for 40m, 20m, 17, and 10m.

80m
Not as good around the UK as the Windom - probably due to the maximum current being in the vertical section. Modelling shows the antenna to be down about 10dB on a low dipole.
30m
Lithuania similar. Other EU and Italy similar. Bulgaria down 2 S points
17m
Similar – inverted L has slight edge at times. Slightly noisier
15m
Better than Windom by about 1 S point.
10m
Much better than Windom, dipole and mag loop around Europe via Es, by about 2 S points. Slightly more noise (+ 1 S point).

From this I can see that I need to do more tests, especially on 20m, but for an all-in cost for the antenna of about £15-£20 it shows promise. If you have a tree then the up and out idea with a 65ft wire looks quite good. A way to get 40m back would be to put a 40m trap in the wire at the 10m mark. If you don't fancy making your own UnUn you can buy the whole antenna from the Snowdonia Radio Company for £35 inc P&P – see http://www.snowdonia-radio-company.co.uk/srcproducts.html [From a collection of excellent articles from G0KYA] Link to SRC: http://www.snowdonia-radio-company.co.uk

GWhip Antennas, and ProWhip Antennas all supply this type of antenna as a commercial item.

CONCLUSIONS?

Arguably the most effective, simplest and, indeed, cheapest way to attain multi-band operation is by using a full size resonant dipole for each band of interest - perhaps having a couple suspended at any one time and swapping aerials when other bands are needed.

As mentioned in the introduction this is a little inconvenient which is why the holy grail of so many amateurs is one antenna that that will do everything - perfectly. As we have seen such an aerial does not exist, and never will due to those pesky laws of physics. Compromises will always have to be made; compromises of efficiency, size, number of bands and bandwidth per band etc - nevertheless there are enough options available to be able to choose a configuration of antenna or antennas that should be able to make the best use of precious transmitter power for a particular circumstance.

My two key criteria are that the antenna should be truly resonant on the band(s) of interest and that the radiating elements should be as near to full size as possible, relative to the wavelength(s) being used, to ensure the best possible efficiency (i.e. lowest loss of power). This means full size quarter wave vertical or full size half wavelength long trapped dipole.

I don't especially like aerials that are shortened by using a loading coil, but accept that such an arrangement is sometimes necessary for the longer wavelength bands. Top Band is a real problem in average size gardens. Where the is a coil, a trap, or transformer there will be some loss or reduced efficiency introduced into the antenna system. I do find that using a trap is an excellent compromise - the 80m / 40m Inverted L and the 20m / 10m trapped dipole work especially well. If I could not use the Inverted L, my next favourite option is the Loop or a fan (Parallel) dipole.

All the pros and cons have to be weighed up to find the best compromise for particular operating circumstances. I hope that this page has given new operators some ideas to take away and mull over, but remember those words from Joe Tyburczy WB1GFH that this page started with:

"When you put up your antenna is also crucial. I must mention here the importance of what many early hams called "antenna weather". That is, snow, sleet, freezing rain, or combination of all the above. It has been proven time and time again that any antenna installed in conditions better than abysmal will not function worth a darn. Or, put another way, it takes bad weather to put up a decent antenna. Dark and cold New England winter days are ideal for this activity. Any antenna erected on such a day will inevitably produce miracles."

Some Further Reading:

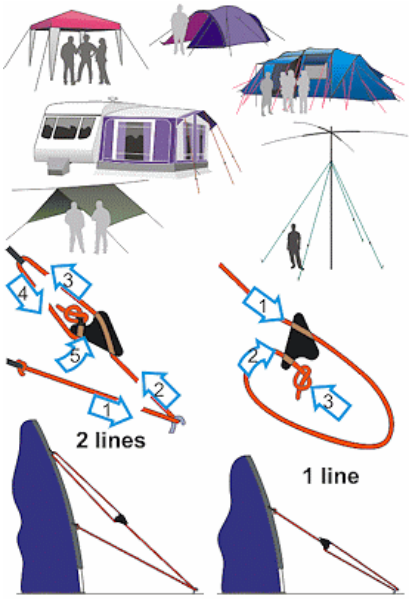
Understanding Antennas For The Non-Technical Ham
A Book By Jim Abercrombie, N4JA
basicantennas.pdf

More Antenna Ideas by other amateurs (.doc)

ARRL document Multi Band Dipoles Compared (.pdf)

High Quality Baluns and UnUns Available From www.gwhip.co.uk

Useful Aerial Rigging Accessories



Line-Lok guy runners from ClamCleats - fantastic for guying antenna masts quickly and successfully
http://www.cleats.co.uk http://www.clamcleat.com

Reusable Nylon Hose Clip / Reusable Circular Clamps
Useful for securing telescopic fibreglass poles - e.g. holding each section in place in windy weather or to use as a guying ring (spider)
(Herbie Clips) (Kaf-flex Nylon Clamps)
http://www.malpasonline.co.uk
http://news.thomasnet.com
http://www.hclfasteners.co.uk/acatalog/Herbie-Clip.html
http://www.cheapham.com/products/S9V31-Replacement-Clamps.html
http://rotocon.homestead.com/shoponline2.html

OTHER THINGS THAT MAY BE NEEDED:

POLE(S) Aluminium, fibreglass or wood ; POLE TO POLE CLAMPS ; MET POST(S) ; NYLON CORD or PARA CORD ; SPIDERS / 3 or 4 WAY GUY RINGS ; PULLEYS ; SNAP HOOKS ; DEE SHACKELS ; GROUND STAKES for anchoring guy ropes ; DOG BONE or EGG INSULATORS ; DIPOLE CENTRES ; EARTHING STAKE ; V BOLTS ; ROPE GRIPS ; THIMBLES ; SLEEVE JOINER(S) ; T&K BRACKETS ; TRIPOD or other GROUND MOUNTING HARDWARE ; STAINLESS STEEL M6 Nuts Bolts and Washers ; SPADE and / LUG TERMINALS ; SELF AMALGAMATING TAPE ; HEATSHRINK ; WEATHERPROOFING SEALANT ; STAINLESS STEEL JUBILEE CLIPS.

TRIMMING AERIALS

Antenna Trimming Chart

This following information below could be very useful indeed when constructing aerials and is compiled by DX Zone / Radio Works from the web page at: http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=13444

Use this chart as an aid in trimming the length of your antenna. It gives you an idea of the change in wire length needed to move antenna resonance a specific number of KHz.

* Dimensions are for each leg of a half-wave dipole
* For quarter-wave antennas (i.e. verticals) use the dimensions directly from this chart
* Full-wavelength antennas (loops) - multiply the chart dimensions by four (4) and change the overall length of the antenna by that amount.

Lengths are estimates. Many factors will affect their exact value.

To move	80/75 m	40 m	20 m	15 m	10 m
-500 kHz	+8' 4"	+2'	+8"	+3"	+1.5"
-400 kHz	+6' 8"	+1' 9"	+6.5"	+2.5"	+1.25'
-300 kHz	+5'	+1' 4"	+5"	+1.75"	+1"
-200 kHz	+3' 4"	+10"	+3.25"	+1.25	+5/8"
-100 kHz	+1' 7"	+5"	+1.5"	+1/2"	+3/8
00 kHz	0	0	0	0	0
+100 kHz	-1' 7"	-5"	-1.5"	-1/2"	-3/8"
+200 kHz	-3' 4"	-10"	-3.25"	-1.25	-5/8"
+300 kHz	-5'	-1' 4"	-5"	-1.75"	-1"
+400 kHz	-6' 8"	-1' 9"	-6.5"	-2.5"	-1.25'
+500 kHz	-8' 4"	-2'	-8"	-3"	-1.5"

Example:

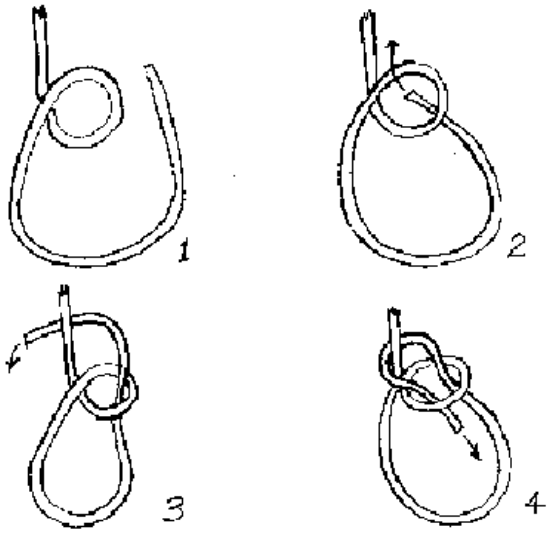
You have measured the SWR of your 40 meter dipole at various frequencies across the band. You have determined that the SWR is lowest at 7.00 MHz. You actually want the lowest SWR to occur up in the sideband portion of the band, so you need to move resonance up in frequency about 200 KHz.

According to the chart, to move +200 KHz on 40 meters, you will have to shorten each leg of the dipole 10" (-10"). The overall length of the antenna is shortened a total of 20 inches.

Lengthening or shortening the antenna is done at the end insulators. To shorten the antenna, unwind the antenna wire as it wraps around itself at the end insulator. Move the insulator several inches toward the center of the antenna. Re wrap the antenna wire to secure the end insulator. Do not cut the wire. Wrap it back around the antenna wire. You may need to increase the antenna later. [From Radio Works / DXZone]

KNOTS FOR SECURING WIRE ANTENNAS

I have found the Bowline to be one of the most useful, it is strong and easy to tie. A Bowline will not slip in any circumstances and, usefully, the more load that is put on it, the tighter it gets.



The Bowline Knot

A Bowline can be used to tie two ropes together and should be used to tie a support rope to a pulley, dipole centre and other antenna items.

It's important to use the correct knot for the job when fixing up wire antennas. I find the Bowline is a very useful for fixing end, egg and dog-bone insulators to the ends of the wire and/or ropes.

The Buntline Hitch is an excellent knot as is the Round Turn & Two Hitches, Anchor Bend (Anchor Hitch) knots which are very good for tying a rope to a pole or a mast.

The Bowline is most useful for fixing end, egg and dog-bone insulators to the ends of the wire and/or ropes.

A Double Sheet Bend can join two pieces of rope together - even if they are of unequal size.

'Animated Knots' will show you how to do them. Visit http://www.animatedknots.com

More websites with knot information : http://www.netknots.com/ http://www.southee.com/Knots/Index.htm

The correct knot will ensure that the antenna will be as strong as possible.

LINKS

Understanding Antennas For The Non-Technical Ham - A Book By Jim Abercrombie, N4JA :
PDF Book: http://www.hamuniverse.com/basicantennas.pdf
HTML page: http://www.hamuniverse.com/n4jaantennabook.html

G4ILO - Stealth Antennas: http://www.g4ilo.com/stealth.html

All Band Doublet Antenna by M0MTJ :
http://www.mds975.co.uk/Content/amateur_radio_antennas_06.html#All_Band_Doublet_Antenna

All Band Doublet Antenna : http://www.hamuniverse.com/hfdoublet.html

All Band Doublet Antenna by AI4JI : http://www.ai4ji.com/Projects/antennas/doublet.htm

All Band Doublet Antenna by G3RWF: https://rsars.files.wordpress.com/2013/01/80-10m-doublet-antenna-g3rwf-11.pdf

All Band Doublet Antenna by W4NEQ: http://w4neq.com/htm/doublet.htm

All Band Doublet Antennas and Baluns by G4POP: http://g4pop.blogspot.co.uk/2008/10/doublet-antennas-and-baluns-my-friend.html

All Band Doublet Antenna by VK6YSF: http://vk6ysf.com/allbandhfdipole_Mk2.htm

All Band Doublet Antenna by M0DAD : http://www.delboyonline.co.uk/m0dad/doublet_all_band_antenna.htm

Introducing the "All-Band" Doublet: What the Student and the Instructor Should Keep in Mind by L. B. Cebik, W4RNL :
http://ftp.unpad.ac.id/orari/library/library-sw-hw/amateur-radio/ant/docs/Introducing%20the%20All-Band%20Doublet.htm

M0WYM - QRP Fan Dipole: http://www.radiowymsey.org/FanDipole/fandiploe.htm

Multi Band Dipoles Compared: http://www.arrl.org/tis/info/pdf/9611073.pdf http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7499

Practical Dipole Antennas Compared: http://www.qsl.net/ta1dx/amator/practical_dipole_antenna.htm

What Antenna For H.F? by Wrexham ARS: http://www.qsl.net/wars/construct/hf_ant.htm

Multiband Loft Dipoles: http://www.qsl.net/g0kya/multibanddipole.pdf

My Top Five Backyard Multi-Band Wire HF Antennas by L. B. Cebik, W4RNL:
http://www.users.on.net/~bcr/files/backyard%20wire%20antennaes.pdf

More Links

Loop Antennas - Delta Loops and Square (Quad) Loops and more:

Delta Loops for HF - "You'll love lower noise and relative gain over a dipole"
http://w5sdc.net/delta_loop_for_hf.htm

One Stealthy Delta - This HF antenna keeps a low visual profile while attracting plenty of attention on the air. An excellent and amusing article by Steve Ford, WB8IMY
http://www.sgcworld.com/Publications/Articles/237qst0502.pdf

Random length multi-band delta loop antenna – A good antenna for when a dipole isn't enough by KC8AON
http://www.i1wqrlinkradio.com/antype/ch10/chiave1827.htm

An Easy to Install Vertical Loop for 80-6 Meters by John Reisenauer, Jr. KL7JR
http://www.hamuniverse.com/kl7jreasyvertloop.html

40m-10m DELTA LOOP ANTENNA - GU3WHN
http://www.rsars.org.uk/ELIBRARY/ANTENNAS%20DOCS/40m-10m%20%20DELTA%20LOOP%20ANTENNA%20-%20GU3WHN%20iss%201.3.pdf

M0PLK Multiband Delta Antenna - By Arthur M0PLK (SQ2PLK)
http://pdxa.one.pl/articles.php?article_id=17 available at http://ham-radio.urbasket.eu and http://www.vpa-systems.pl/

H5ANX Mk4 Delta Loop Design by Sajid Rahim
http://www.eham.net/articles/10738

Multiband H.F. Delta Loop by IW5EDI:
http://www.iw5edi.com/ham-radio/?dl2hcb-multiband-delta-loop,28

SGC Stealthy H.F. Delta Loop:
http://www.sgcworld.com/Publications/Articles/237qst0502.pdf

KL7JR Easy H.F. Delta Loop:
http://www.hamuniverse.com/kl7jreasyvertloop.html

H.F. Loop Antenna from Radioworks:
http://www.radioworks.com/nloop.html

W6ZDO Portable H.F. Delta Loop Project:
http://www.fros.com/KI0GU/w6zodelta.htm

Loop Antenna Notes by "Yukon John" KL7JR
http://www.hamuniverse.com/kl7jrloopnotes.html

Build a Multi-Band Mono Delta Loop for 40, 30, 20 and 15 Meters by Jose I. Calderon (DU1ANV)
http://www.para.org.ph/membersarticles/DU1ANV/Multi-Band%20Mono%20Delta%20Loop%20ant.pdf

DL2HCB Multiband Delta Loop
http://www.iw5edi.com/ham-radio/?dl2hcb-multiband-delta-loop,28

The Delta Loop (Skywire) Antenna - Legends, Theory and Reality
http://dk5ec.de/deltaloop-eng.htm

Loop Antenna notes and ideas from Radioworks
http://www.radioworks.com/nloop.html

Delta Loops by GW7AAV
http://www.cqhq.co.uk/2009_05_01_archive.html

More Delta Loop links:
http://www.i1wqrlinkradio.com/antype/delta_loop.html

Magnetic Loops:

Small Transmitting Loop Antennas (Magnetic Loop Antennas) by Steve Yates - AA5TB
http://aa5tb.com/loop.html

Fibreglass Telescopic Fishing Poles

http://www.sotabeams.co.uk

http://www.skyblueleisure.co.uk/acatalog/Telescopic_Poles.html

see: Bowmanarcher on ebay

Line-Lok guy runners for support pole guy ropes by ClamCleats (excellent) :
http://www.clamcleat.com/cleats/cleats.asp?menuid=7

Other Aerial Supports

http://www.tecadi.de/

Commercial Antennas

GWhip Antenna Products: http://www.gwhip.co.uk/

Spectrum Communications: http://www.spectrumcomms.co.uk

Sandpiper Aerial Technology: http://www.sandpiperaerials.co.uk

SOTA Beams: http://www.sotabeams.co.uk/

W.H. Westlake - for wire, cable, feeder, connectors & components: http://www.whwestlake.co.uk/

Moonraker: http://www.moonrakerukltd.com

AERIAL PARTS Of Colchester: http://www.aerial-parts.co.uk

SRC - Snowdonia Radio Company: http://www.snowdonia-radio-company.co.uk

Cobwebb Antenna: http://www.g3tpw.co.uk

ProAntennas: http://www.proantennas.co.uk

ProWhip Antennas: http://www.prowhipantennas.co.uk/

Hustler Antennas from DX Engineering. 4-BTV, 5-BTV & 6-BTV compact antennas: http://www.dxengineering.com

Butternut Antennas from Bencher Inc: http://www.bencher.com/ham/

Cushcraft Antennas from MFJ: http://www.cushcraftamateur.com

Comet Antenna: http://www.cometantenna.com

Diamond Antenna: http://www.diamond-ant.co.jp/english/amateur/antenna/ama_antennas.html

Hygain Antennas from MFJ: http://www.hy-gain.com

Alpha Delta Communications - Dipole and Parallel (Fan) Dipole Multi-Band Antenna Designs http://www.alphadeltacom.com/

WIMO Antennas and Accessories: http://www.wimo.com/cgi-bin/verteiler.pl?url=wireantennas_e.html

GAP Antennas: http://www.gapantenna.com

True Ladder Lines and Wire Antennas: http://www.trueladderline.com/index.html

Radio Wavz - wide range of amateur radio antennas: http://www.radiowavz.com

Radio Works - amateur radio antenna manufacturer and supplier: http://www.radioworks.com/

Force 12 Antennas (Sigma5) : http://www.force12inc.com

Transworld Antennas (TW2010 Adventurer) : http://transworldantennas.com

Superantennas: http://www.superantennas.com

Amateur Radio Suppliers

RADIOWORLD http://www.radioworld.co.uk/

ROCKET RADIO http://www.rocketradio.co.uk/

SPECTRUM COMMUNICATIONS http://www.spectrumcomms.co.uk/

MOONRAKER http://www.moonrakerukltd.com/

HAYDON COMMUNICATIONS http://www.haydon.info/

KZJ Communications (DeeComm) (Haydon West Midlands) a good shop on EBAY at http://stores.ebay.co.uk/kzjcommunications

WATERS & STANTON http://www.wsplc.com/

MARTIN LYNCH & SON http://www.hamradio.co.uk/

DIODE COMMS http://www.diodecomms.co.uk

NEVADA RADIO http://www.nevadaradio.co.uk/

LAM COMMUNICATIONS http://www.lamcommunications.net

ANCHOR SUPPLIES http://www.anchorsupplies.com

VINE ANTENNAS: http://www.vinecom.co.uk/

Projects and Information

Flower Pot Antenna - http://vk2zoi.com - and interesting link to an interesting antenna design that was very kindly sent to me by Phil M6MRP

G4ILO - Stealth Antennas: http://www.g4ilo.com/stealth.html

M0WYM - QRP Fan Dipole: http://www.radiowymsey.org/FanDipole/fandiploe.htm

See Multi Band Dipoles Compared: http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7499

See Practical Dipole Antennas Compared: http://www.qsl.net/ta1dx/amator/practical_dipole_antenna.htm

The ALL Band HF Doublet on Ham Universe: http://www.hamuniverse.com/hfdoublet.html

Multi-band Inverted V $4 Special by Joe Tyburczy, W1GFH: http://www.qsl.net/wb1gfh/antenna.html
http://www.hamuniverse.com/fourdollarspecialw1gfh.html

The Norcal Doublet Antenna: http://www.norcalqrp.org/norcaldoublet.htm

N4JTE - 6 Band Ribbon Dipole by N4JTE
http://n4jte.blogspot.com/2009/04/n4jte-6-band-ribbon-antenna-35.html

http://g8jnj.webs.com/

http://www.astromag.co.uk/vertical/

http://www.hamuniverse.com/multidipole.html

http://www.hamuniverse.com/fourdollarspecialw1gfh.html

http://n4jte.blogspot.com/2009/04/n4jte-6-band-ribbon-antenna-35.html

http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=20420

http://www.tc006a8364.pwp.blueyonder.co.uk/brats/radio_07/advanced/mathequat_1.htm

http://www.tdars.org/library/TechTopics/tech22.html

http://www.rsgb.org/tutors/advanced/pdf/maths_primer.pdf

http://www.users.icscotland.net/~len.paget/Mini%20quad.pdf

http://www.users.icscotland.net/~len.paget/5%20band%20Inverted%20L.pdf

http://www.users.icscotland.net/~len.paget/Inverted%20L%20adding%20top%20band.pdf

http://www.btinternet.com/~shaun.scannell/club/w3dzz.htm

http://homepage.ntlworld.com/lapthorn/70cms.htm

http://mw0idx.co.uk/2mPortPockBeamGW0VMW.html

http://www.dxzone.com

http://www.arrl.org/tis/info/pdf/0207040.pdf

http://www.dxzone.com/cgi-bin/dir/jump2.cgi?ID=7466

W2BLC - Amateur Radio Antenna Ideas: http://www.w2blc.us/linkant.htm

End Fed Antennas

GWhip End Fed Antennas:
http://www.gwhip.co.uk

Cross Country Wireless designed and manufactured End Fed Antenna
http://www.crosscountrywireless.net/end_fed_antenna.htm
http://www.crosscountrywireless.net/CCW_End_Fed_Antenna_Operating_Manual_v1.1.pdf

Hy End Fed antennas - single and multi band end fed antennas by PA3EKE.
http://www.hyendfedantenna.nl http://www.pa3eke.nl
Review of Hy End Fed antenna by PC4T: http://dutchhamradio.blogspot.com/2010/09/hy-end-fed-antenna.html

Par End Fedz Antennas - now manufactured and supplied by Larry, AE4LD of LNR Precision End Fedz:
http://www.lnrprecision.com

W3EDP and Other Antenna Links

http://va3qv.wordpress.com/tag/w3edp-antenna/

http://va3qv.wordpress.com/2009/10/18/good-results-with-re-worked-w3edp/

http://ve3clq.blogspot.com/2011/01/w3edp-antenna.html

http://bv3fg.tripod.com/ant/end_fed.htm

http://ham-antennas.blogspot.com/2011/02/dl2hcb-multiband-delta-loop.html

http://sv3auw.blogspot.com/2009/11/sloper-7mhz.html

Back to Aerial Types....

More "thinking out loud" notes and queries which I intend to edit and condense (honestly!):

Multi Band HF Antennas

Covering ALL the HF bands with separate antennas dedicated to each band would take up a large amount of space which many of us don't have. Either we must decide on a limited number of favourite bands and put up a specific antenna for these or try to find a multi band antenna that covers all the bands of interest.

The perfect HF multi band is many an amateur radio operator's holy grail. If you haven't already seen it, you can read more about an All Band Antenna Marvel covering 160m to 70cms on this external link: Hamuniverse ALL BAND N4UJW Antenna

So, multi-band antennas necessarily involve compromises which usually translate into lower efficiency i.e. the antenna will not effectively radiate all the power that is fed to it. There will be losses, some large and some not so large depending on the design and the number of bands that the antenna is attempting to cover. The 80m / 40m Inverted L, mentioned above, is down by about 2dB on 80m when compared to a full size 80m inverted L. That's not too bad, but it does still mean a theoretical best case scenario of about a 40% loss of power! So if 100 watts of power arrives at the antenna (disregarding additional feeder losses) then only 63 watts will be radiated - actually less due to any feeder and other losses.

If these compromises are accepted then there are a number of different multi-band antennas that can be considered. Having a small plot I have had to consider many such designs, some are vertical antennas some are horizontal wires, some are commercial products and some can be 'home brewed'.

Home brewing a wire antenna is relatively straightforward since wire is easy to obtain and work with. A wire antenna is typically installed horizontally above the ground, although it may also be installed as an Inverted V or as a Sloper.

A wire antenna is easy to adjust for resonance and often reasonably straightforward to suspend in the air using existing structures, buildings, trees or simple wooden posts.

Home brewing a vertical antenna might present slightly more difficult mechanical and engineering challenges to produce a stable and, perhaps, visually acceptable device.

Standard Wire Dipole

In my own circumstances I could probably fit in a couple of dipoles up to about 15 metres (45 feet) in length. For a straight dipole, such a short length would preclude 160m, 80m and even 40m. So dipoles that could fit in a fairly small space would give two of the bands between 30m and 10m.

Loaded Dipole

Loading a dipole with a centre or end inductor on each arm would maintain its electrical length while reducing the antenna's physical length. This would allow the antenna to be resonant on the required band and enable the longer wavelength bands to be used even though efficiency will be less than a full size, un loaded, dipole.

A loaded dipole will be relatively easy to construct, the most time consuming part being the winding of the inductor coils and their subsequent adjustment to obtain the desired physical length at the correct resonance. An antenna analyzer is a very useful piece of test equipment for speeding up these adjustments.

Trapped Dipole

The use of traps can effectively split the antenna into two or more resonant sections. Using one trap on each arm of a dipole will transform a single band dipole into a dual band dipole. Using two traps on each arm will enable the dipole to be resonant on three bands. A four band trapped dipole would use three traps etc. Traps also shorten the overall physical length of the dipole which might be seen as an advantage, however traps tend to be lossy and short antennas obviously do not radiate as efficiently as their full size counterparts. Once again the compromise for covering more bands, and in less space is effective radiated power loss.

Traps can be quite tricky to home brew, though it is entirely possible. As an alternative traps can be purchased pre-made from some amateur radio suppliers such as Spectrum Communications. The other time consuming part of d.i.y. construction a trapped dipole will be adjusting the antenna wires so that the aerial is at resonance on each band. Again an antenna analyzer is a very useful piece of test equipment for speeding up these adjustments.

Fan or Parallel Dipole

An alternative to using traps is to use the fan dipole (parallel dipole) method. This essentially connects two or more full size dipoles together at the centre feeder point. For example, whereas a single band dipole would have one pair of 'arms' a four band fan dipole will have four pairs of 'arms' arranged in a fan like pattern. The fan dipole will be very straightforward to physically construct although it will be quite tricky to get each dipole to the correct resonance for each band since each arm will interact with its close neighbour. Again an antenna analyzer is a very useful piece of test equipment for speeding up these adjustments.

The Fan / Parallel dipole should be a very efficient and effective radiator since all the dipole elements are full size, however its bandwidth on each band might be be narrower than a trapped dipole, though it should be less lossy.

Most designs of Fan / Parallel Dipole (even commercial ones) seem to opt for coaxial feeder. Personally I don't think that this is a good idea. I would use twin feeder to feed this type of design (probably 72 ohm twin or similar) for three reasons.

1. Twin feeder is far and away less lossy than coax, so when an antenna has reduced bandwidth and one is forced to operate with a higher vswr than might be considered ideal, the subsequent feeder losses in coax will be very high indeed compared to to losses in twin feeder which will be much lower.
2. A dipole is a balanced antenna, and coaxial cable is an un-balanced feeder - not a good match...
3. Using un balanced coax with a balanced antenna would customarily demand the use of a balun at the centre of the dipole which is another point that could induce power loss.

For all those three reasons twin feeder seems to be the better, more efficient option.

Combination of Trap, Inductive Loading and Fan arrangement

There is no reason why a combination of a techniques might not be employed to produce a multi band dipole. Just as one example, a fan dipole with two pairs of arms could be made to cover four bands by using a pair of 7.1MHz traps in one pair of arms to create a 80m / 40m dipole and load the end of the dipole with an inductor to shorten its physical length. A second trapped dipole could be added to cover 20m and 10m using a 28MHz thereby making a fan dipole with two pairs of 'arms'.

Loop / Delta Loop

A loop antenna is remarkably easy to make and install and in my experience very easy to match using a good ATU. A relatively small loop made up of an 17 or 18 meter length of thin wire is light weight and should be visually inconspicuous and will work from the 30 metre to the 10 or even 6 metre band. A neat multi band solution that could be put up and taken down, as required, reasonably quickly.

Commercially Manufactured Options: Just a few designs that may be attractive for use on a small plot.

Wire Dipoles:

Interesting parallel dipole with end loading:

Alpha Delta Model DX-EE Parallel Dipole (40-20-15-10) - A Fan Dipole only 12 metres long. Reasonable design, though fed with coax. (I'd build one and use twin feeder.)

Similar design from Alpha Delta, but too big for my plot:
Alpha Delta Model DX-CC Parallel Dipole (80-40-20-15-10) - Fan Dipole design, 25 metres long.

Some interesting trap dipole designs:

Diamond W8010 - Trapped Fan Dipole for 80m, 40m, 20m, 15m and 10m only 19.2 metres long.

Comet CWA-1000 - Trapped Fan Dipole for 80m, 40m, 20m, 15m and 10m Similar to Diamond W8010 19.8 m long.

[Thinking out-loud: Could take the 80m segments and 7MHz traps off the ends of both the W8010 or CWA-1000 to produce a shorter antenna covering 40m, 20m, 15m and 10m that would only be about 13.6 metres long?]

KZJ - Restricted Space Inductive Dipole (trapped?) Straight - For 80m, 40m, 20m and 10m only 16.5 metres long.
KZJ - Restricted Space Inductive Dipole (trapped?) Straight - For 160m 80m, 40m, 20m and 10m 22.3 metres long.

Top quality designs:
Spectrum Communications 80m + 40m Dipole fed with twin feeder and will cover other bands up to 10 meters.
Spectrum Communications 40m + 20m Dipole fed with twin feeder and will cover other bands up to 10 meters.
Spectrum Communications 80m + 40m Inverted L. Will cover other bands up to 10 meters.

Verticals:

Usually very short when compared to the wavelength being used so power loss may well be very high. Might be useful in very restricted spaces where nothing else really will fit in. A vertical antenna can provide better low angle radiation which can provide better long distance DX.

G Whip G Pro wide band whip antenna - perfect resonance on the 40m band and 80m to 10m with 'A.T.U.'
Sandpiper V10 and derivatives. Depending on bands covered, between 4.2 m and 6 metres tall.
Sandpiper MV10 and derivatives. Depending on bands covered, between 2.5 m and 4.2 metres tall.
Butternut HF9-V covers 80m, 40m, 30m, 20m, 17m, 15m, 12m and 10m. - 7.9 metres tall
Diamond CP6 covers 80m, 40m, 20m, 15m, 10m and 6m. - 4.6 metres tall.
Diamond CP5-H covers 40m, 20m, 15m, 10m and 6m. - a mere 3.6 metres tall.
Comet / Maldol HVU-8 80m, 40m, 20m, 15m, 10m, 6m, 2m, 70cms. - tiny at only 2.6 metres tall.
GAP Eagle DX 40m, 20m, 17m, 15m, 12m, 10m. - 6.4 metres tall.

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